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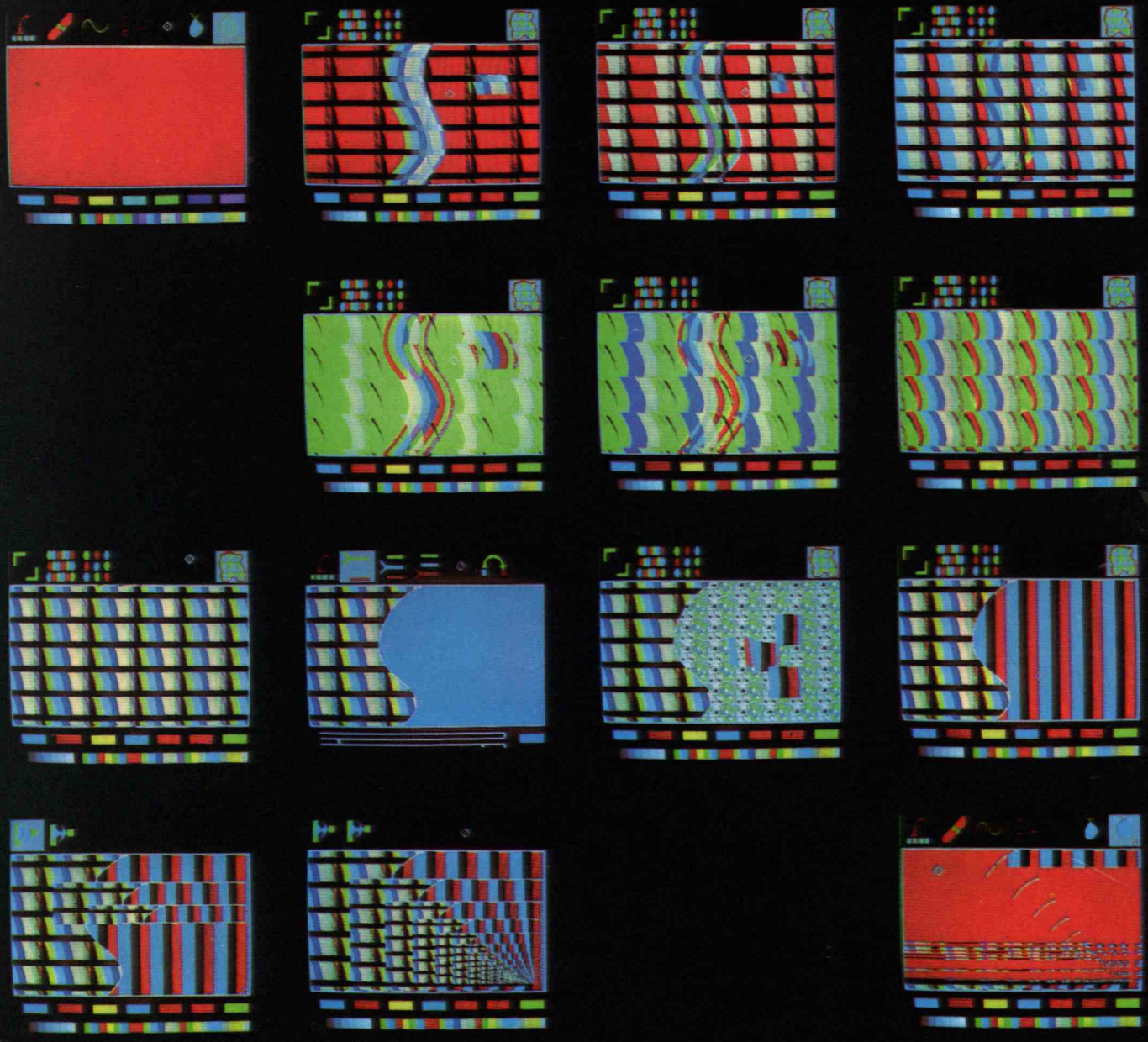
Innovaha!tion

Technology Review

Edited at the Massachusetts Institute of Technology

Painting by Computer:
New Realms for Animation
See page 34

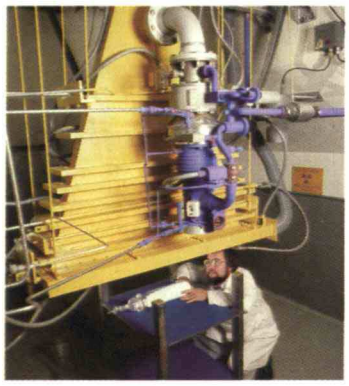


technology
review
Published by MIT

Making plastic-filler marriages last longer.

Incompatibility and stress have been known to cause rifts in many an otherwise perfect union.

Take polypropylene, for instance. This thermoplastic is often wedded with inorganic fillers such as talc or kaolin to increase heat resistance and stiffness.



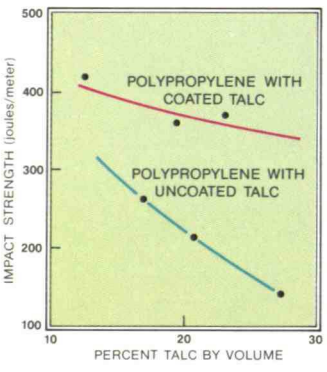
But the resulting union responds poorly to the stress of impact. Shock waves tend to start cracks around the filler particles—mostly because the plastic doesn't cling to the filler. It just surrounds it.

Our polymer scientists here at the General Motors Research Laboratories set out to strengthen the plastic-filler composite by introducing a compatible, shock absorbing interface. The trick was to get the interface material to stick to the filler.

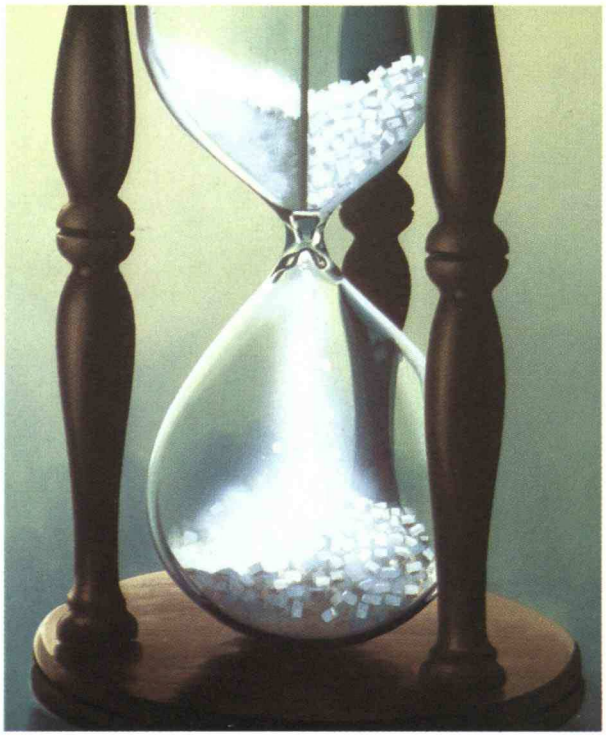
How did they do it? First they adsorbed a monomer, 2-ethylhexyl acrylate, on the filler particles. Then they irradiated the coated filler, under vacuum, with high energy electrons (photo above).

The radiation did two things: It polymerized the monomer coating. And it chemically linked this coating to the filler, as revealed by thermogravimetric analysis and carbon-14 tracer techniques.

As a result, some plastics are now able to bond tightly to fillers through an elastic interface. In the case of polypropylene and talc, that means about twice the impact strength as before (see graph).



We call this experimental technique "radiation grafting on fillers." It's only one of the approaches we're exploring to help make plastic products live happily ever after.



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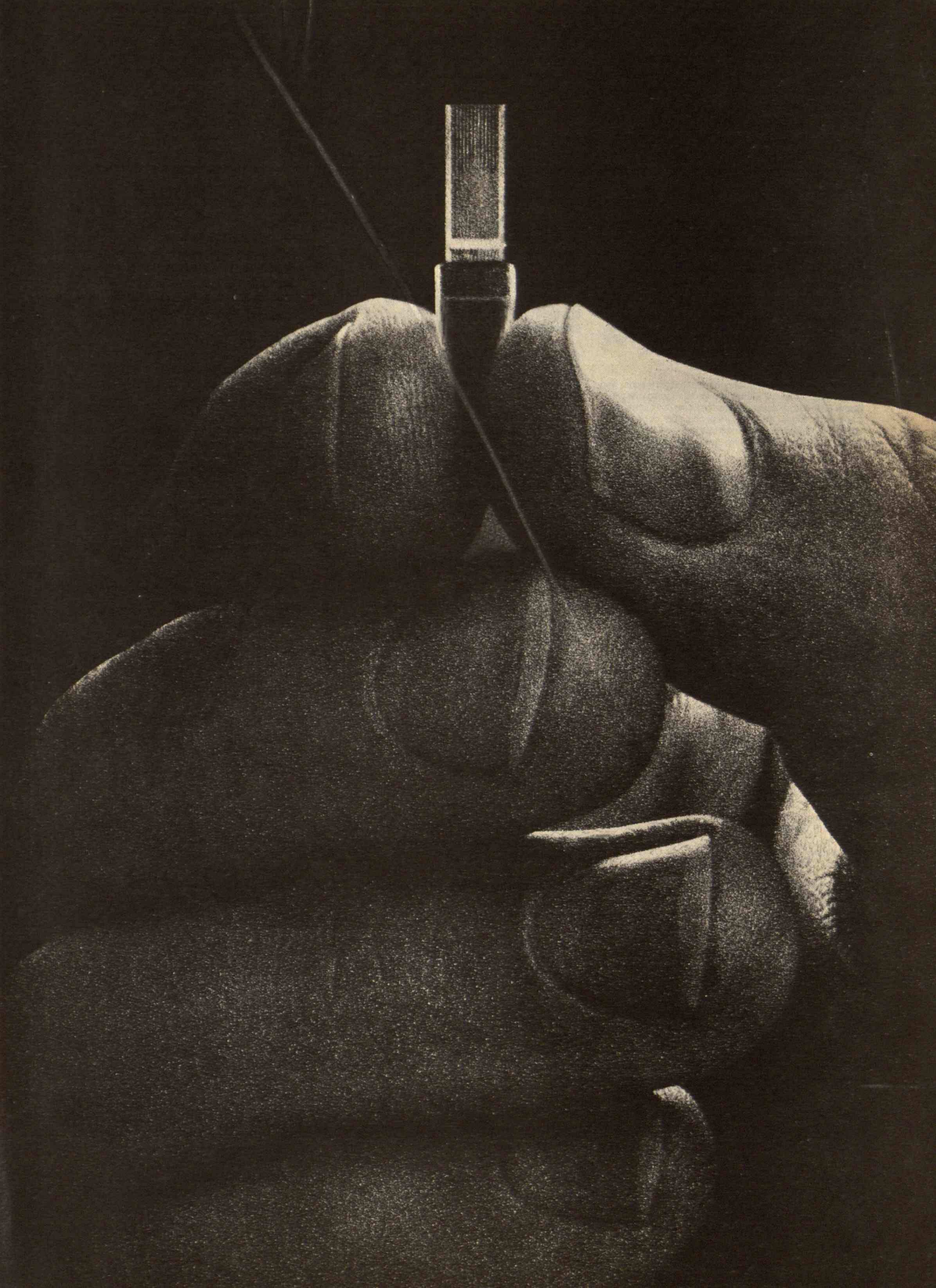


The Chicago Connection.

With it, the phone system of tomorrow is in Chicago today.

A while ago, we told you lightwave communications was just around the corner. Today, it's in the streets of Chicago.

For the first time, the human voice, business data and even video signals are being carried by lightwaves traveling over hair-thin glass fibers. Instead of electric current traveling over copper wire.

But without that little link you see on the opposite page, lightwave communications for such a wide range of services might still be an experiment in a lab. And without Western Electric technology, the link might still be a design on a blueprint.

The link is an outgrowth of an idea from the people at Bell Labs. While they were putting the major components of the lightwave system together, they had to find a way to splice the glass fibers and get the light across the splice.

A Simple Idea

The idea they came up with was deceptively simple. A coupling device made up of tiny grooved chips, smaller than the tip of your finger, that would guide the ends of the hair-thin fibers and butt them up in perfect alignment.

There was only one hitch. Making one chip was easy. But there was no machinery that could mass produce all the identical chips that would be needed for a lightwave system like the one in Chicago.

Making Ideas Reality

That's where Western Electric comes in. Turning ideas into technological innovations is nothing new at Western Electric.

Over the years, Western Electric has piled up an impressive list of innovations that have become manufacturing standards.

It was the first company in the world to manufacture the transistor.

It was the first to put the laser to work as a useful production tool.

And it is the company that went beyond conventional machining techniques to make the chips for Chicago's lightwave system.

Each chip is pure silicon crystal. Its internal structure (a criss-cross arrangement of intersecting planes) provides a built-in blueprint for regularly spaced grooves. And because the crystal's diagonal planes etch faster than its perpendicular planes, uniform grooves can be chemically cut into the chip.

By combining the science of chemistry and the art of lithography, Western Electric's Engineering Research Center developed a way to etch 12 ultra-precise, perfectly shaped, identical V-grooves on each chip. With each groove no wider than a hair and separated only by a hair's breadth from its neighbors.

And, more importantly, they were able to reproduce these chips so that each one was a perfect double of the other.

Teamwork is the Key

The telecommunications revolution beginning in Chicago is another good example of how Western Electric and Bell Labs help put new technology into practical use for the Bell telephone companies, quickly and economically.

Their close relationship is an important reason why your telephone system is the most efficient and reliable communications system in the world. And it's a basic reason why innovations in technology are a common occurrence in the Bell System.

Western Electric

First Line

Five Years Among the Engineers

Sara Jane Neustadtl has worked as a writer and editor in the world of engineers and engineering since 1972, when she joined the Engineering Publications Office at the University of Illinois — Urbana. It was only three months later (and no coincidence) that a member of the M.I.T. faculty called *Technology Review*'s attention to the special qualities of the University of Illinois' newsletter, *Engineering Outlook*. Integration of these events meant that Ms. Neustadtl joined the Review's Board of Editors in July, 1973, after receiving her M.S. degree from the College of Communications in Urbana.

Since then Ms. Neustadtl has managed our "Trend of Affairs" section, in which the initials "S.J.N." must have become ever-more-familiar to our readers. Other features of the magazine, too, have increasingly carried the imprint of Ms. Neustadtl's talents. And that will be still more certain in the future, for Ms. Neustadtl has now become our Managing Editor, succeeding Dennis Meredith whose departure was reported with regret in this space in our July/August issue. — *J.M.*

The Argo Merchant: A Correction

The caption provided by the Editor for the frontispiece of "Being Prepared for Future Argo Merchants" *(July/August, page 15)* is incorrect. As readers of his article will know, it is *not* Professor Jerome H. Milgram's thesis — as implied by the caption — that loss of the Argo Merchant's cargo was avoidable, given our present state of readiness to deal with such disasters. Rather, the thrust of his argument is that losses need not be inevitable in the future, with adequate technology — most of which is now well understood — and resources and conditions for its utilization. — *J.M.*

Letters

How Nutritious Is Meat?

The principal conclusion of Ian C. T. Nisbet's "You Are What You Eat" *(June, p. 5)* — "So more than half the energy and protein harvested by American farmers is used to produce nothing more useful than animal dung" — does not follow from the statistics cited.

The facts Dr. Nisbet reports are few enough that it is easy to survey them. First are the amounts of feed grain necessary to produce a pound of beef (16 lbs.), pork (8 lbs.), or chicken (6 lbs.). However, Dr. Nisbet offers no evidence as to the relative amounts of nutrients per pound that these meats contain compared to feed grain.

Finding no statistics with which to calculate the percentage of grain's nutritional value that goes to waste in the American diet, I moved on. The only other factors Dr. Nisbet cites are these:

☐ The United States' grain consumption per capita is more than twice the world average.

☐ Two thirds of the grain consumed by Americans is consumed indirectly as meat.

By combining these two claims with various assumptions of parameters that Dr. Nisbet did not mention, I was able to arrive where Dr. Nisbet did. However, the two claims together or even combined with earlier figures on the amount of grain required to produce meat led me nowhere by themselves. I challenge anyone to reach Dr. Nisbet's conclusion from his figures.

For the sake of those whose chance to view the big picture comes only when they can sit down with a good magazine written by people who think on a global scale all the time, a more complete rendering of the arguments would be appreciated.

Leslie J. Harmer
Newport, R.I.

Dr. Nisbet replies:

The offending passage is indeed illogical, but is not what I originally wrote. The word "So" was added by the editors in a mistaken attempt to clarify an overconcise paragraph. We regret the confusion.

Mr. Harmer (together with some other correspondents) seems to have missed the main thrust of my article. It was not primarily about nutrition, nor primarily about waste. It was intended to be a survey of the environmental impacts of food production and their dependence on consumer choice. Since production of animal products accounts for more than half of U.S. agriculture, including a disproportionate fraction of its environmental and economic impacts, meat quickly became the central theme of the survey.

The article was one of a series exploring the options available to an individual who is concerned about the impact of his or her everyday activities on the environment of others. To make the conclusion of the article more explicit, such an individual can do at least as much by reducing consumption of meat as by more conventional environmental restraints — and will save money and improve his health at the same time.

Who Pays for Nuclear Power?

However administrative responsibility for disposal of West Valley's nuclear wastes is discharged and whatever method of disposal is used, the issue of financial responsibility is serious and goes well beyond issues of federal vs. state responsibility *("The Nuclear Wastes at West Valley, New York," David Rose and Richard Lester, May, p. 20.)* The authors relegate this issue to undeserved obscurity.

West Valley provides strong evidence that the Purex process for nuclear reprocessing is only technically feasible if enormous government subsidy is provided. In the case of West Valley, this subsidy will amount to roughly $800 million for offsite solidification. Even if we attribute only a fractional share of these costs to the nuclear industry in proportion to the wastes that they have contributed to West Valley, the taxpayer has been presented with a multi-hundred dollar bill.

The lesson that West Valley teaches is that the full cost of electricity being generated today in nuclear plants is being borne by neither the utilities' users nor by their stockholders. Because some business failures in any industry are likely (to say nothing of the potential for financial failures in the nuclear industry itself where costs are often much higher than originally expected), these costs will be borne by the taxpayer years from now. In effect, we are providing an unfair competitive advantage to nuclear power when compared with coal, oil, natural gas, and solar energy. This hidden nuclear subsidy must be eliminated and nuclear utilities required to internalize it before we can determine whether nuclear technology is truly "feasible."

Neil B. Goldstein
New York, N.Y.

Mr. Goldstein is New York Representative of the Sierra Club. — Ed.

Dr. Rose and Mr. Lester reply:

We agree with Mr. Goldstein that financial responsibility is central to the future role of nuclear power. But our paper dealt with a different topic — how to approach a unique problem generated in the past and with us now. Surely Mr. Goldstein would not insist on a complete resolution of financial responsibility for pollution of rivers, for example, before public authorities could begin to clean them. A variety of lessons can be drawn from the experience at West Valley. Rather than consigning any of them to undeserved obscurity, as Mr. Goldstein suggests, our paper proposes a schedule for action that seeks to minimize the possibility that another lesson, based this time on the costs of further delay, will have to be added to the curriculum.

Replacement and Repair: Healing the Body Politic

Kenneth E. Boulding is Director of the Institute of Behavioral Science and Professor of Economics at the University of Colorado at Boulder. He is a regular contributor to Technology Review.

A few weeks ago I was making a wild dash to catch a plane at the Denver airport. I dove between two cars in the rather dark parking lot, did not notice a transverse sidewalk, hit it at a considerable clip, sailed into the air like a bird, and came down on my chest.

I picked myself up and proceeded to Buffalo, returned and took off on yet another trip, came back again in some pain, and was finally reduced to seeing a doctor. He x-rayed me and diagnosed a broken rib. My inquiry as to the remedy met with the answer, "Absolutely nothing." These days they don't even tape you up; they just advise you to take things easy. And since the only place I can relax is on an airplane, the injury didn't interfere much with my travels. For a couple of weeks every time I coughed or sneezed I felt as if I were going to explode. I experienced a strong fellow feeling with Adam. Then the pain gradually subsided and in about three weeks, I didn't notice it any more; the rib had obviously healed.

This experience set me pondering the healing processes not only of the body but also of society. I saw many of the bombed cities of Europe in 1949. Twenty years later one had to look carefully to see any evidence of the war. Similarly a volcano erupts in Iceland, almost burying a little port; in a couple of years the ash is all shoveled away and apart from the memory of the night of terror, all is back to normal. Without this almost miraculous homeostasis of systems everything would soon fall apart and there would not be enough continuity to permit the ongoing flux of evolution.

Social Genetics

The sources of these healing processes are by no means clear. Nor is it clear whether we assist or hinder them by our supposedly therapeutic activity. There is at least folklore to the effect that the medical community only began to do more good than harm in about 1910. I continue to be skeptical of other supposedly therapeutic communities, especially politicians.

One principle is clear: the healing that takes place after catastrophe could not take place if consumption and production did not go on all the time. The healing powers of the body are undoubtedly related to the genetic material and information in the cell. The process that healed my rib cannot be terribly different from the one that made it in the first place. It is the turnover of the body — the fact that it is unobtrusively decaying and being rebuilt all the time — which is the necessary condition of the healing process.

We see the same phenomenon in the recovery of cities or societies from disaster. Everything depreciates. We constantly have to devote resources to replace everything. A disaster is simply an enormously rapid depreciation, and the damage is repaired just as usual — only more quickly. Without this turnover — that is, without consumption and production — healing would be impossible. A pot, for instance, has no turnover. Once it is produced in the kiln, that's that. No process of continual decay and replacement preserves the pot as it preserves a living organism. So we may glue the pieces together, but the pot will never be the same; it will never knit and be healed.

These observations illuminate the role of consumption in society. I have argued for 30 years — without much conviction that anyone was listening — that human welfare is a function of the capital stock rather than of the throughput of consumption and production (measured by such indicators as GNP). The obsession of economists with consumption as a measure of welfare, for which we must blame Adam Smith, has prevented us from understanding the true nature of welfare.

We get very little satisfaction out of the fact that our clothing wears out, that our houses and automobiles depreciate, or even that the gasoline in our tanks burns up. Use is not equivalent to consumption. I enjoy sitting in a chair; I do not enjoy the fact that my sitting contributes to the chair's eventual collapse and abandonment. To be well off is to be healthy, well fed, and to enjoy an agreeable physical and social environment — not to produce and consume a lot. If the period of turnover (the average period of "production" in the language of the Austrian economists) is fairly constant, then production and consumption as measured by GNP is at least a fair measure of the total stock of social goodies. And it is thus a fair measure of economic welfare. Changes in the rate of turnover weaken the validity of the GNP as a measure of human welfare. For the rate of turnover to increase, capital stock must remain stable and production and consumption must diminish. This is the basis of economic efficiency, and is usually very desirable.

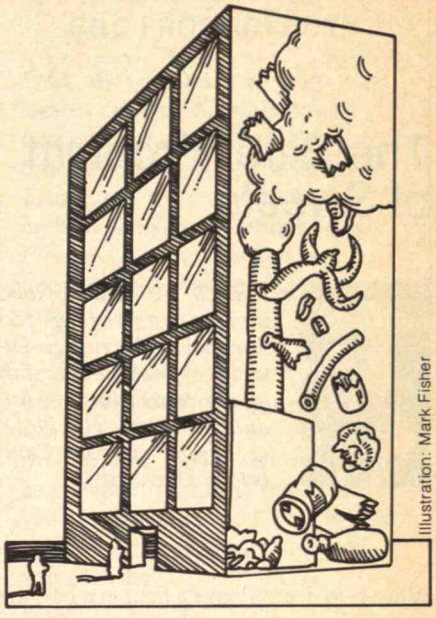


Illustration: Mark Fisher

New Suit, New Shirts, New Spouse

The proposition that capital stock has prime importance for social welfare still seems to me true, however neglected. Nevertheless, production and consumption do participate in the welfare function, to some degree independent of the capital stock — for good evolutionary reasons. We take satisfaction, for instance, in eating as well as in being well nourished. Eating is very clearly consumption. If we could be implanted with a little energy-producing capsule and thus relieved of the necessity to eat for the rest of our lives, I doubt many of us would take the option. We have a taste for variety: we do not really want our clothes to wear forever; we like to acquire a new suit, new shirts, even a new spouse.

All this requires production and consumption — clearly elements in the total welfare function, though they have a curious nonlinear relationship with the total stock. If we eat too little because we're not hungry, we will not be well fed. On the other hand, if we eat too much, we will also not be well fed; we will grow fat and our health will suffer. There may be a fundamental evolutionary reason for the average life expectancies of different species. A society of Methuselahs would have too few births and deaths in proportion to the population. It might be unable to recover from catastrophe. If my body did not enjoy the constant throughput that comes from eating, I would not have

Continued on p. 23

by Ian C. T. Nisbet

The Bitter Problem of Sweets

Ian C. T. Nisbet, who writes regularly for Technology Review, *is Director of the Scientific staff of the Massachusetts Audubon Society. His Ph.D. in Physics is from Cambridge University.*

When two drunks have a fight in a bar, the one known to be an habitual drunkard is sent to jail, whether or not there is any evidence that he started the fight. This is McPherson's Rule, an ancient tenet of Scottish law. The U.S. Food and Drug Administration formulated its own McPherson's Rule when faced with a thorny problem in 1969. Experiments had shown that rats who dined on a mixture of cyclamate and saccharin developed bladder cancer. Under the Delaney Amendment to the Food, Drug, and Cosmetics Act which prohibits use of cancer-causing substances in foods, the F.D.A. was therefore required to prohibit the use of one or the other — or both — as food additives. After brief but doubtless agonizing discussions, the F.D.A. invoked the McPherson principle and banned cyclamates. Cyclamate was condemned, like the aforementioned drunkard, on the basis of prior reputation rather than proof of miscreancy. (This, of course, is not to imply that either was innocent.)

Since 1969, the results of additional experiments have suggested that saccharin alone can cause bladder cancer in rats. Unfortunately none of these results have been conclusive one way or the other, as the tests have been plagued by mishaps, mistakes, and muddles. However, by the time the F.D.A. reviewed the cyclamate ban in 1975, the cumulative evidence against saccharin was so strong that if McPherson's Rule had held sway, saccharin would have been condemned. It was logical for the F.D.A. to refuse to lift the ban on cyclamate, whose safety was questioned on other grounds, but the continued postponement of action against saccharin — an implicit verdict of innocence — is puzzling.

Early this year, evidence finally showed conclusively that saccharin causes bladder cancer in rats. To those familiar with the earlier data, the F.D.A.'s response in banning the use of saccharin as a food additive was merely a long-overdue response to evidence that could no longer be ignored. Surprisingly, many people who had previously worked for effective regulation of cancer-causing substances, as well as manufacturers and consumers of saccharin, attacked the decision. The gauntlet was quickly taken up by the opponents of food additive regulation who have long sought to modify the Delaney Amendment. The saccharin ban provided a forum from which to attack the amendment, and the fundamental principles of cancer testing as well. However, it happens that F.D.A. picked a very poor example on which to rest its case.

The experiment, conducted in Canada, which triggered the furor was as straightforward and decisive as such experiments ever can be. Two generations of rats were fed a diet containing 5 per cent saccharin for the greater part of their lifetimes. Bladder cancers, which are rare in untreated rats, were found in 14 per cent of the male rats in the first generation and in 24 per cent of the male rats in the second generation. The increased risk in the second generation males was striking, indicating fetal damage in those whose mothers consumed saccharin during pregnancy.

Like any well designed cancer test, the Canadian experiment involved a compromise between practicality and realism. Ideally, one would test the effect of saccharin in rats at doses similar to those consumed by humans, and seek a small effect. One cancer per thousand rats would be of major concern. However, such an experiment would require many thousand animals. Chemical tests at relatively high doses are necessary in order to detect an effect in a practical sample of 50 to 100 rats. This widely misunderstood principle was used to discredit the experiment as "unrealistic." Saccharin's defenders were quick to promote the idea that "a person would have to drink 800 cans of diet soda every day" in order to match the saccharin intake of the afflicted rats.

Keeping Tab on Rats

At first glance, 800 seems to be a comfortable margin of safety. But the calculation is misleading. We humans are typically more sensitive than rats to doses expressed in milligrams per kilogram of body weight (equivalent doses tend to be proportional to surface area rather than weight). We are exposed to saccharin not only in diet soda, but in many other foods: in drugs, in toothpaste, and as sweetening in drinks. A habitual saccharin user ingesting the equivalent of several cans of soda would approach the equivalent dosage

Illustration: Jon McIntosh

consumed by the rats within a factor of 100. This is disturbing when one considers that 14 to 24 per cent of the rats developed cancer. Even assuming that humans are no more sensitive than rats, a habitual saccharin user is exposed to a substantial risk.

The second main argument used by the proponents of saccharin is that the evidence of risk to rats is outweighed by experience in humans. However, although saccharin has been used for 80 years, without good epidemiological studies of the general population, we would not find evidence of ill effect even if ill effects were to be found. Recently a new epidemiological study comparing users of saccharin with matched non-users has been completed. It shows markedly elevated risks of bladder cancer in male saccharin users: the risks increase both with the amount of saccharin consumed and with the duration of exposure. For heavy consumers with the longest history of use, the risk of bladder cancer appeared to be about twice that in the general population — 40 to 50 cases per 100,000 per year. Although no single study of this kind can be conclusive by itself, the parallels between these results and the controlled experiments with rats make those who sought to discredit the latter look rather foolish. The evidence suggests that saccharin, although a rela-

"It seems peculiarly repugnant to impose a cancer risk by deliberately adding a chemical to food."

tively weak carcinogen, has been consumed in sufficient quantity to pose a substantial, identifiable risk to its users.

The saccharin episode prompts some thoughts about the Delaney Amendment — although not the thoughts that were urged on us by those who argued that saccharin was safe. By law, the F.D.A. may permit only those substances proved to be safe to be used as food additives. The Delaney Amendment, passed in 1958, forbids the F.D.A. to deem safe any substance "if it is found to induce cancer when ingested by man or animal. . . ." The Agency may use scientific judgment and administrative discretion in deciding whether or not a chemical has been "found" to induce cancer, but may not use discretion in setting "acceptable" levels of carcinogens in food.

The discretion denied to the F.D.A. for food additives is granted to other regulatory agencies. The Environmental Protection Agency has permitted certain limited uses of carcinogenic pesticides, and has set numerical emission standards for pollutants such as vinyl chloride, determining specifically in each case that the risks of such uses appeared to be outweighed by the benefits. The Occupational Safety and Health Administration has similarly set numerical standards for occupational exposure to vinyl chloride and asbestos. The Department of Agriculture has set permissible levels for nitrites in bacon, although there is little scientific doubt that such use poses risks of cancer. The F.D.A. itself registers certain carcinogenic drugs where the benefits outweigh the risks — such as those used to treat existing cancer. Moreover, the F.D.A. has announced itself willing to consider licensing saccharin as a drug if concrete evidence of health benefits is produced.

The Price of Luxury

Food additives are unique in their regulatory treatment. It seems peculiarly repugnant to impose a cancer risk by deliberately adding a chemical to food — more so than by dispersing a chemical in the environment with the knowledge that traces of it will turn up in food. But more important, food additives as a class are viewed as luxuries rather than necessities. Most of them are used simply to improve the appearance, texture, or marketability of food, or to prolong shelf life for the convenience of the retailer. Extremely few additives — nitrite in preserved meats being one of the rare exceptions — are necessary to ensure the safety of food. It is extremely unlikely that a thorough analysis would show that saccharin conveyed any substantial health benefits to offset its risks: no other miracle cure for obesity has stood up to critical scrutiny.

In an ideal world, the rational resolution of a dilemma like that of saccharin would be to conduct a careful analysis of risks and benefits. However, as pointed out above, there is still vigorous argument about the magnitude of the risks, and analysis of the benefits has scarcely even begun. Underlying the entire debate about the Delaney Amendment is a widespread feeling that the F.D.A. cannot be trusted to carry out risk-benefit analyses rationally: the food industry attacks it bitterly for its actions against cyclamate and red dye no. 2, while environmentalists attack it similarly for postponing action against saccharin and for weak regulation of PCBs.

Sweet Blindness

The ultimate question raised by the saccharin ban is that of consumer freedom. Why should the individual be denied a product he or she wants, simply because an arcane scientific experiment suggests to a remote bureaucrat that it poses a small risk? Why not permit the consumer to make the risk-benefit judgment on an individual basis? The simple answer to this question is that individuals do not make these risk-benefit judgments well enough. The examples of smoking and automobile accidents show that what individuals perceive as acceptable risks lead to unacceptable burdens upon society. But a more fundamental answer is that individuals do not have enough information to make rational estimates of the risks, especially for risks such as cancer which are remote in time. The average member of the public has no understanding of why rats are used in safety testing, nor why chemicals are tested at high doses — and certainly is not helped by the barrage of misinformation from interested parties.

So in the end our sweet problem is bitterly unresolved. The public lacks information and probably lacks the judgment to make decisions on complex issues; the government cannot be relied upon to make rational judgments. This is a characteristic dilemma of our technological age. □

Founding Our House Upon a Rock

Robert Cowen, Science Editor of the Christian Science Monitor, *writes regularly for* Technology Review. *He is former president of the National Association of Science Writers.*

Disaster experts warn that extensive and careless land development that fails to anticipate floods, hurricanes, earthquakes and other such events risks catastrophe.

It is a risk that need not be. "Natural hazards are inevitable in the use of the earth, but natural diasters are not," says Clark University geographer Robert W. Kates, who specializes in peoples' attitudes toward such hazards. For much of the nation's history, he notes, people could build and live carelessly and the risk they ran was largely their own. Not so today. Any one catastrophe could involve hundreds of thousands of people, billions of dollars in property value and economic investments, and a heavy public charge for disaster relief.

Dr. Kates isn't talking only about such highly visible risks as those of California earthquakes. He is concerned also with the less visible and equally large risks now run by millions of people who have injudiciously moved into coastal regions prone to hurricane flooding; who are populating canyons subject to flash floods such as the one that swept Big Thompson Canyon last year, and whose neglect of sound land use in flood zone communities has become synonmyous with Johnstown. He is also concerned with earthquake risk east of the Rockies where quakes are relatively few but where potential damage is enormous — just because planning and development take so little account of the hazard.

It's time for the United States to face up to these needless risks and come to better terms with nature. Perhaps our greatest challenge is to become aware of what's needed and to find the political will to do it. A good deal must be accomplished.

Misguided Fatalism

Tornadoes offer a case in point. From one perspective, tornado risk management is already a success. Herbert S. Lieb, head of the Disaster Preparedness Staff of the National Weather Service, says that as late as 1950, tornadoes weren't forecast for fear of causing a panic. In the 27 years since then, the Weather Bureau (now the National Weather Service) has developed an impressive capacity for tornado forecasting and warning. Equally important, it has encouarged public awareness of tornado hazards and community contingency planning that, especially in the 27-state tornado belt, has made the tornado warning system a life-saving tool. "In the late 1940s there was about one death per reported tornado. Now only about one death in 9 or 10 reported tornadoes occurs, a ninefold reduction," says Mr. Lieb. "We attribute this to a preparedness posture, an awareness that has led to effective action."

Nevertheless, tornado experts are not satisfied. They still find too much of what engineer Joseph Minor of Texas Tech University calls "misguided fatalism": the belief that there's little you can do to protect property from direct tornado attack. Together with his colleagues Kishor Mehta and James MacDonald, Dr. Minor has studied thousands of tornado-damaged buildings. He is convinced that homes, schools, factories, and commercial buildings can be built to resist most of the tornados that occur in the U.S. Alan Pearson of the Naional Severe Storms Forecast Center in Kansas City, Mo., who works closely with Dr. Minor's group, shares this conviction: "Of the 125 people lost to tornadoes in an average year, 100 die needlessly. They don't hear the warnings, or they don't take them seriously. . . ." Mr. Pearson also stresses that foresight could reduce tornado risk.

A Tornado Shelter for Every School

To begin with, Dr. Minor says the old storm cellar is outmoded for cities. Protection should be built inside the buildings themselves. While a basement shelter is best, a reinforced interior room, closet, or hallway will do. For schools, he prefers to build protection around central rooms. Even open plan buildings usually have interior cloak rooms and rest rooms that would suffice. These precautions need not be expensive. "We've built shelters in new homes for less than $1,000 using common materials such as concrete blocks and steel-reinforcing doors," says Dr. Minor.

Alan Pearson, who is especially concerned with schools, agrees that cost is not inhibiting. He believes that all communities east of the Rockies, whether in the tornado belt or not, should identify or build tornado shelters in their schools and hold regular drills in their use. There's no need for expensive consultants or elaborate remodeling programs. He points out that most parent-teacher associations include one or more civil engineers or architects who can find out what's needed and make an assessment at little cost. Both Drs. Pearson and Minor are happy to advise architects, engineers, and homeowners, and to provide many practical tornado safety tips as well as extensive technical information. Interested readers should write the Disaster Preparedness Office, National Weather Service, 8060 13th St., Silver Spring, Md. 20910.

Dr. Minor adds that reducing property damage need not be expensive either. A simple measure such as firmly anchoring a house roof to the walls and the walls to the foundation significantly increases tornado resistance. "People tend to think 'Since it was a tornado, I couldn't have done a thing about it.' That's a misperception," he explains. "Only 2 per cent of tornadoes are so powerful you can't build to resist them. About 90 per cent of tornadoes have wind speeds of less than 150 m.p.h. People in hurricane belts routinely design for such winds . . . economically." Inquiries should be directed to the Institute for Disaster Research, Texas Tech University, Lubbock, Tex. 79409.

High-Rises Washed to Sea

Disaster experts are hoping we can anticipate other natural hazards as thoroughly as we anticipate tornadoes. An effective forecast and warning system coupled with public preparedness and backed by extensive technical knowledge of practical risk-reducing measures is needed for floods, hurricanes, and earthquake hazards too.

An efficient forecast and warning system already exists for hurricanes. But public awareness is lacking. As the American Meteorological Society warned last year, a couple of decades without major coastal disasters has lulled our sense of caution. Millions of people have moved into vulnerable areas and during the vacation season, these areas attract many millions more. A warning would do these people no good; in many cases, evacuation routes couldn't carry them to safety in time. Here the immediate need is for many communities to re-evaluate evacuation and other emergency plans. The long term need is for better land-use planning and strict building codes. Joseph Minor notes that the foundations of many high-rise buildings now believed to be safe may be scoured out by the violent action of hurricane flood waves.

For other types of floods, the traditional approach to flood management needs overhaul. Too much reliance has been

"It is time to unify disaster management and to emphasize foresight, risk reduction, and where possible, prevention."

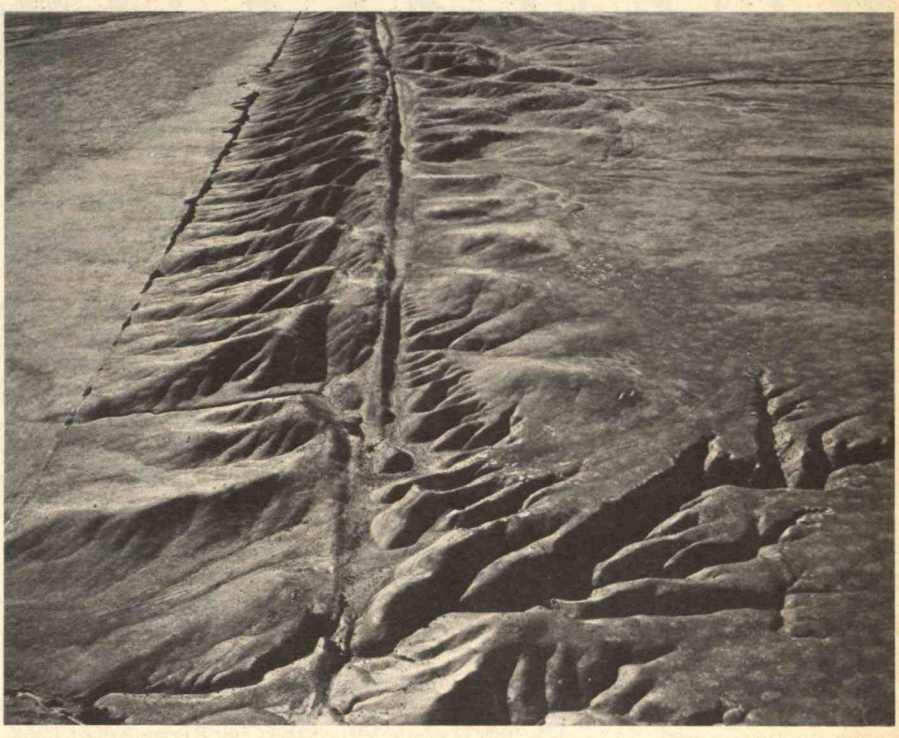
placed on dams, says Dr. Kates. Dams have their place in flood control. But they should be part of an integrated approach that couples timely warning with an effective local emergency plan that all citizens understand. Dams and water channels should be incorporated in an overall land-use plan that prohibits building in unsafe areas.

Earthquakes East of the Rockies

Earthquakes are not an appreciated hazard east of the Rockies. Robert A. Wallace of the U.S. Geological Survey says much attention is paid to obvious quake prone regions such as California and Alaska. But "We don't know whether or not to advise building quake-resistance into buildings in the East. This could add 3 to 8 per cent to building costs — and run into billions of dollars a year. We just don't know what causes these quakes. It's an area where research is needed."

Recognizing this, Congress, at this writing, was considering a three-year, $210 million comprehensive earthquake research program that would include study of eastern quakes. The bill has passed the House and was expected to pass the Senate. Eastern quakes are different from those in the west: they occur in the middle of one of the great crustal plates into which earth's surface is divided — not at the juncture of two plates. Although less frequent than western quakes, they can be devastating. The largest quake ever recorded in North America was near New Madrid, Mo., in 1812. Moreover, Dr. Wallace notes, eastern quakes cover more ground. In California, a damage zone typically measures tens of miles in radius and the shock is felt for hundreds of miles. In the east, the damage zone is measured in hundreds of miles and the "felt zone" in thousands of miles.

The quake hazard is serious in the East because massive development has ignored it. Communities needn't wait for geologists to understand eastern earthquakes before taking corrective action. They can start now to identify unsafe buildings with an eye to reinforcing or phasing them out later. Emergency plans can ensure that vital services would survive a major quake. And building codes can be revised. To help in this sort of planning, the National Bureau of Standards in cooperation with the National Science Foundation has just produced comprehensive recommendations for consideration by building code organizations. These include proposed standards relevant to all parts of the country to reduce earthquake risks. Furthermore, N.B.S.-N.S.F. have begun a program to evaluate the recommendations by applying them to design of typical buildings; the results should be available in about two years. Anyone interested in the new proposed standards or the evaluation program should write the Center for Building Technology, Institute of Applied Technology, National Bureau of Standards, Washington, D.C. 20234.



The San Andreas fault — which runs the length of California — is unmistakable evidence of the probability of earthquake. Yet the state's population grows unchecked, and new construction continues. East of the Rockies, earthquake hazard is also great — and taken even less seriously by land developers and architects. The result could be catastrophic. (Photo: U.S. Geological Survey)

Lemmings

The disaster challenge has come upon the United States largely because the country has grown and prospered. It is futile to look for "culprits" — negligent developers or foolhardy homesteaders, says Gilbert White of the Institute of Behavorial Sciences at the University of Colorado, (who, like Dr. Kates, studies attitudes toward natural hazards). The economy has boomed, population has burgeoned, and Americans have become extremely mobile. The result is more people living in areas exposed to natural hazards of which they are mostly ignorant. It is asking a lot of people who live in a place for only five years to know about the once-in-50-year flood potential, Dr. White observes.

In the past, federal efforts have been fragmented among several agencies and characterized by a philosophy of post-disaster relief. Dr. White and other experts feel it is time to unify disaster management and to emphasize foresight, risk reduction, and where possible, prevention.

A start is the national flood insurance program, which puts a premium on preventive land-use management and tough building standards in participating communities. More progress is possible with legislation Congress was considering at this writing which would unify federal disaster management in one new agency. But the legislation still emphasizes relief rather than prevention. The next and most urgently needed step is for Congress to thoroughly overhaul the entire disaster management program to encourage sound planning and prevention.

Preventing natural disasters — and preparing for those that do occur — will be a complex and controversial undertaking. And it will be expensive when communities get down to re-zoning and beefing up building standards. But the payoff in long-term safety and economic savings can be immense. As Dr. Kates notes, this is an area where we can have our cake and eat it too. □

Housing in America

Robert Schafer is Associate Professor in the Department of City and Regional Planning at Harvard University. He is a graduate of Harvard Law School and holds a Ph.D. in urban planning with a concentration in economics, also from Harvard.

The U.S. government has sought "a decent home and a suitable living environment for every American family." Yet nearly every federal program seeks to achieve this goal by emphasizing production rather than equitable distribution. As a result, people who live in substandard houses, as well as minorities who must fight discrimination in their choice of housing, have received inadequate assistance. Now as in the past, federal housing funds could be spent to benefit many more people, in greater need.

A Roof Over Every Head

The variation in housing conditions is the most visible aspect of the nation's income distribution. It is a fact that everyone can see as they drive to work, to a shopping center, or to the beach. As long as there is such great disparity in incomes, housing assistance programs will be demanded. They could take a variety of forms. For example, some analysts argue that the close relationship between income and housing quality demands a general income maintenance program and not a program aimed at housing alone. However, many Americans are not willing to shift the income distribution radically, even though they may desire to alleviate some of its effects in areas such as housing. Therefore, the nation must decide whether it wishes to pursue an income maintenance strategy or a strategy specific to housing.

If it is the latter, the federal government should adopt a housing allowance program that provides each needy consumer with the money to buy or rent standard housing in the existing stock. Such a program will restore incentive for quality production, be more equitable, and take advantage of the existing stock.

A frequent rebuttal to proposals for a housing allowance has been that it will artificially inflate the cost of housing. But preliminary results of the Experimental Housing Allowance Program — which Congress authorized in 1970 — suggest that such a program has little or no effect on prices. The Experimental Housing Allowance Program (E.H.A.P.) is an experiment being conducted in 12 metropolitan areas to evaluate alternative versions of a housing allowance. In addition to looking at the effect on housing prices, E.H.A.P. is designed to tell us who will participate, how recipients will spend their allowances, how much their housing will improve, and how landlords will respond.

Local public housing authorities and projects financed at below market interest rate are in financial trouble throughout the country. The reason: our historic concern for production has diverted attention from management problems. The Department of Housing and Urban Development should address management inefficiences with vigor and tenacity; one result of its effort should be more simple, clear, and sound program regulations.

Above all, anti-discrimination laws should be energetically enforced. H.U.D. should accept its legislated leadership role and use its resources to ensure fair housing opportunities for all Americans. Under Title VIII of the Civil Rights Act of 1968, H.U.D. is authorized to conduct well-publicized community-wide compliance reviews throughout the country and to develop equal opportunity regulations for use by all federal agencies. Further, Title VIII permits H.U.D. to take steps to ensure equal access to real estate listings in every metropolitan area. It remains for H.U.D. to seek legislation giving it the power to issue cease and desist orders to landlords, realtors, and developers who violate Title VIII.

Financial Incentives

H.U.D.'s administration of housing and community development programs should reflect a clear and firm commitment to the constitutional and legislative goals of equal housing opportunity. That could be accomplished more easily if housing allowance programs provided an added financial incentive to participants who choose housing in a neighborhood that is predominantly of a different race than their own. Already, Title VIII confers on H.U.D. sufficient authority to implement such a provision under its present housing subsidy program.

In addition to these programmatic recommendations, several organizational changes should also be considered. The Federal Housing Administration (F.H.A.) oversees several unsubsidized mortgage insurance programs, many of which were initiated in the 1930s. Most of these programs have served their objectives, and the federal government's presence is no longer necessary. For example, in 1973 private mortgage insurance companies wrote $13 billion worth of single-family insurance, compared to F.H.A.'s total of $4.5 billion. Furthermore, there is considerable evidence that private companies can manage mortgage insurance more efficiently than the government; F.H.A. has a reputation for lengthy delays in processing insurance applications. So it is time for the federal government to recognize that a once valuable and important function is no longer required; F.H.A. insurance programs should be spun off to the private sector, as was done with the Federal National Mortgage Corporation in 1968.

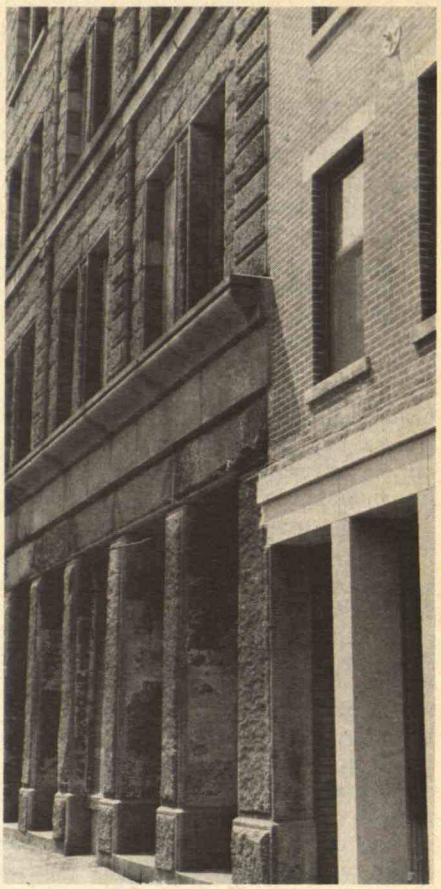


Photo: Steve Glines

The Carter-Mondale administration has a great deal of unfinished housing business awaiting its attention. A more sound federal housing policy would involve a shift in emphasis away from production goals. Better priorities are the use of existing housing units to meet the needs of the poor, the enforcement of civil rights laws, and reorganization of the federal housing bureaucracy. □

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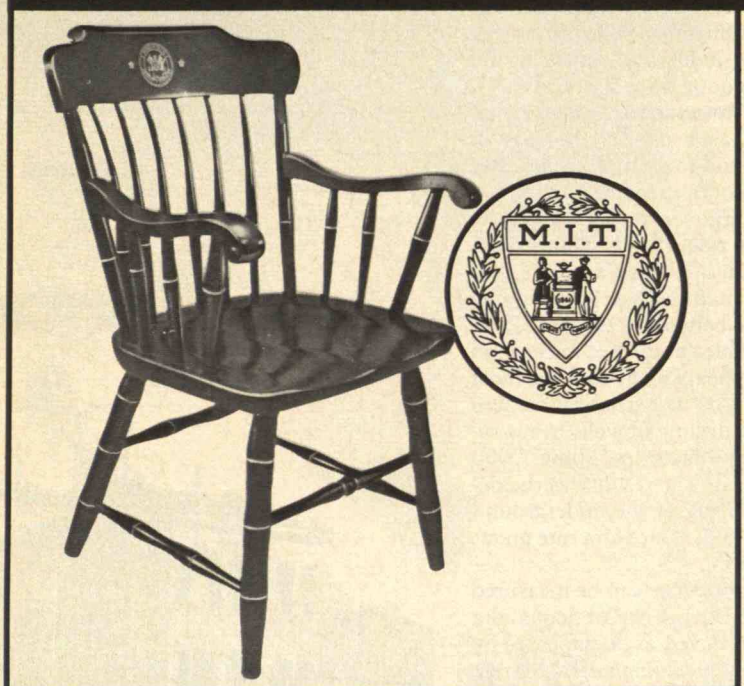

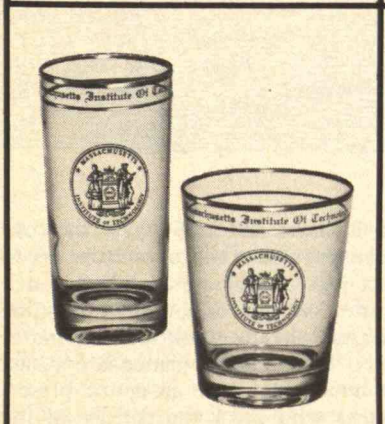

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Venice: Museum or Wasteland?

Nicholas Adams is Assistant Professor of History of Art, specializing in history of architecture, at McGill University. He recently spent two years in Italy researching his dissertation (for New York University) on the relations between Renaissance art and technology.

A college professor of my acquaintance likes to ask his beginning class in political science to close their eyes and imagine the map of the United States after a nuclear war. Do they see a giant wasteland? Or do they see clusters of fallout shelters where Kansas City and Indianapolis once stood?

The question isn't meant to be profound, I suppose; the idea is to encourage the students to think about some of their political prejudices. In the study of Italian politics, one could ask a similar question of Venice. What, the question might go, will the northwest corner of the Adriatic look like in the year 1990? A watery inlet? A futuristic landscape where highways, railroads, and oil refineries unite at a snack bar over the bubble-enclosed ruins of St. Mark's? The question is not so far-fetched. In fact, it is sufficiently realistic that we should be interested in the answer.

In November, 1966, the problems of Venice — the rising sea and the sinking land — became the focus of worldwide attention as water flowed over the city. Money was donated, international committees were set up, and the Italian government was asked to appropriate funds for the endangered city. But since then no dramatic developments have taken place. The high water comes two or three times a season and the question, what will happen to Venice, remains.

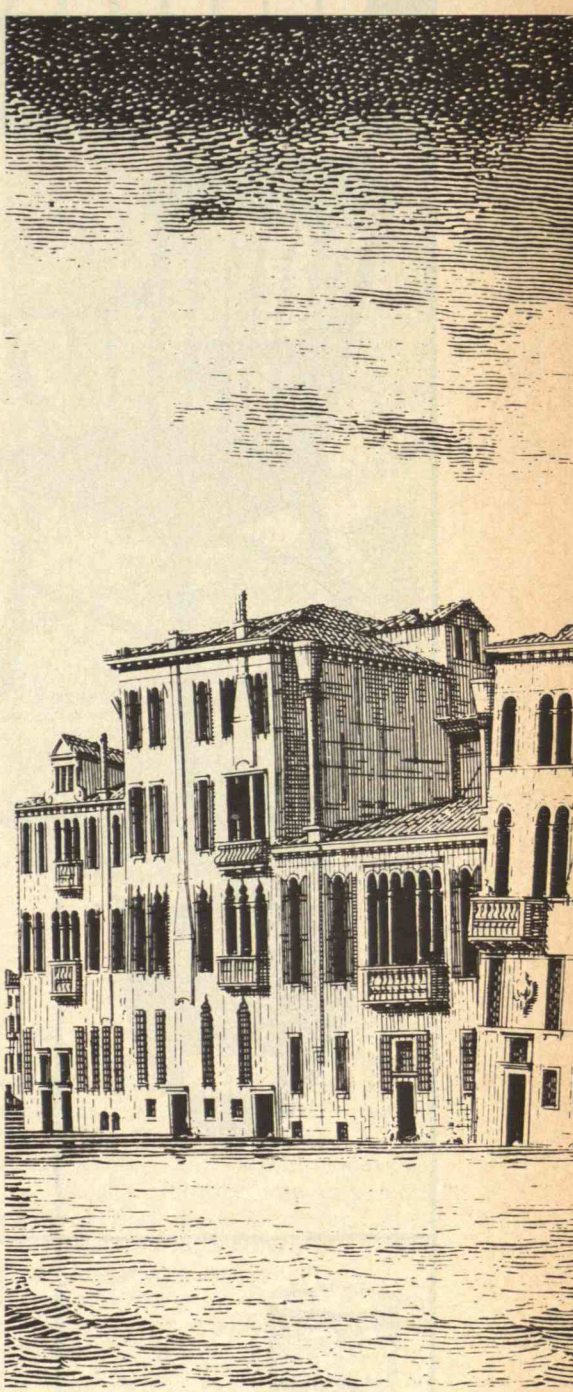
Rise and Fall

The threats to Venice are various, some inherent and unchanging, others decidedly man-made. For example, it has been estimated that the land around Venice has sunk some 70 to 120 in. since Roman times and accounts for a similar rise in sea level. In the past, the Venetians simply rebuilt where the sea invaded, content to use the old buildings as foundations for the new ones. Today our historical conscience has not yet allowed us to sit back and watch a totally new Venice rise on the ruins of the old.

There is general agreement that Venice's present difficulties stem from the construction of industrial zones at the head of the lagoon after World War I. Previously the meandering network of shallow canals that dissect the lagoon slowed the rise and force of the tides. But with the cutting of deep-port facilities and the filling in of large sections of the lagoon for industry, the tides could rush through the lagoon unchecked. Furthermore, the exploitation of natural gas fields in the lower Po Valley between 1935 and 1955 produced a notable subsidence in the land as well. But it appears likely that the most pernicious effect of industrialization was produced by the drilling of wells to supply water for the new factories. Some 7,000 wells were opened. The result was the depletion and lowering of the underground water table and subsidence at a rate greater than ever before.

The rate of subsidence can be measured by the increasing frequency of acqua alta (high water) in the city, as documented by Carlo Berginz (*Civil Engineer,* March, 1971). From 1870 to 1935, the city was flooded on an average of once every five years. From 1935 to 1960, the frequency of high water increased to an average of once a year and from 1960 to 1970, it increased again to an average of three a year. In November, 1966, the water rose some 6 ft. above normal sea level. Since 70 per cent of Venice is less than 50 in. above sea level, the disastrous effects of high water are clear.

In 1973 a three-year ban on pumping underground water took effect and water began to be brought by aqueduct from other parts of the Veneto. The results are not dramatic, but they are significant. Water continues to flood the piazza of San Marco every autumn and winter, but the sinking of the land, according to Ottavio Vittori, head of the Venice Geological Research Laboratory, has stopped.



An Italian Disney World

The city's next steps are crucial. Venice is not rising; it has merely stopped sinking as the underground water table is replenished. Some kind of barrier must now be constructed to prevent the continued erosion of Venice by the sea.

The problems here are political. The $475 million collected by the United Nations Educational, Scientific, and Cultural Organization has yet to be spent and the political logjam cannot readily be unstuck. Business and labor favor the continued expansion of the industrial zones to protect jobs and create new ones. Such expansion would doubtless undermine further the already weak foundations of the city. This unholy alliance is opposed by a holier-than-thou group of preservationists who favor the defense of the city at any cost. Its policy, in the opinion of business and labor, would create a

"As the Communists prepare to come to national power, the stage is set for new policies that will enable the engineers to set to work."

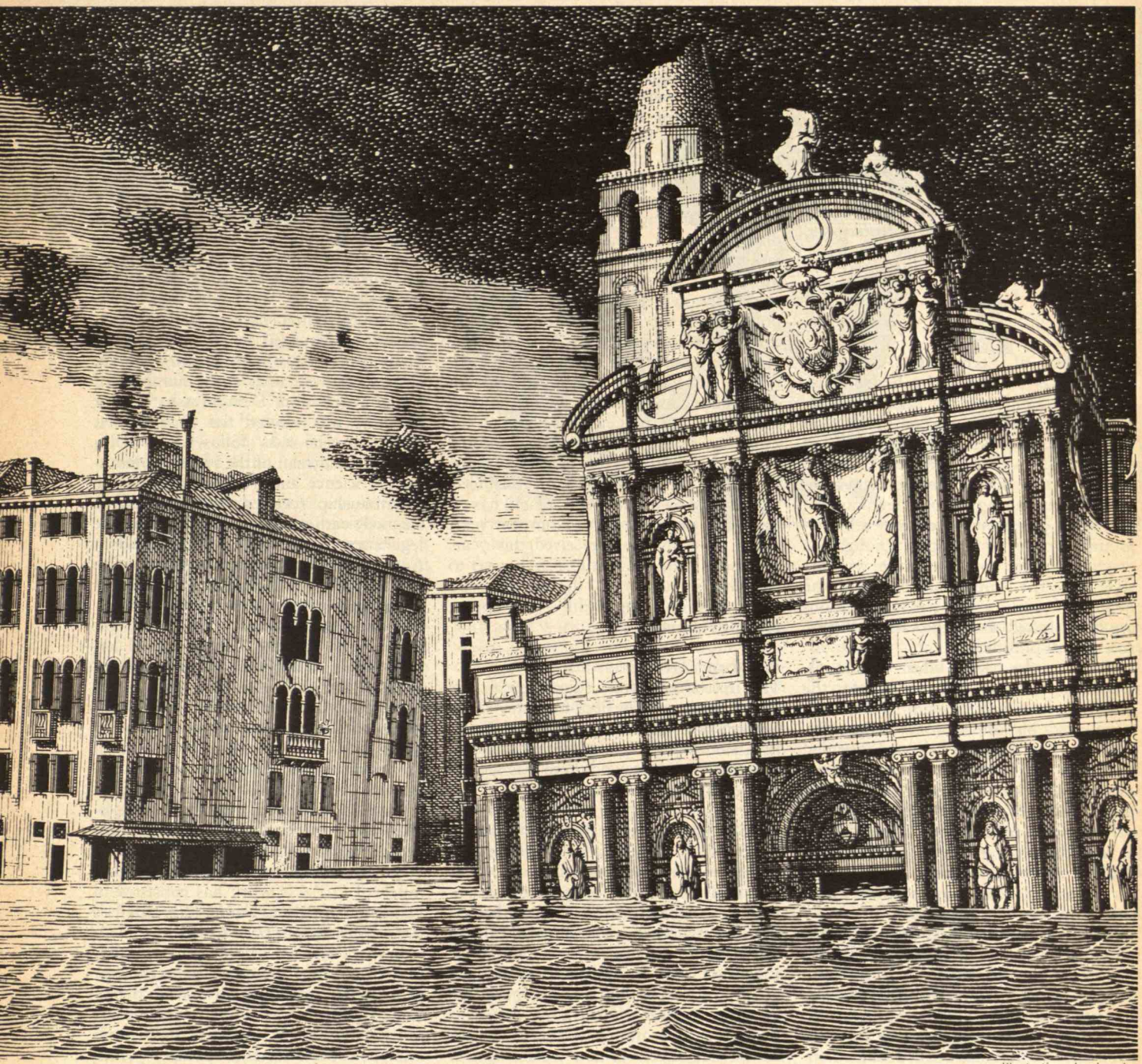


Illustration: Joe Landry

city-museum, a kind of Italian Disney World for the wealthy and foreigners.

It is at this point that the class closes their eyes and we ask what they see.

Whatever compromise is reached, it will reflect Venice's own Byzantine past. However, the attitude of Italian Communists and Socialists towards big business promises the opportunity for a solution (or at least for spending some of the money that has been collected). Anxious for power, the Italian left-wing is also anxious not to create economic and industrial chaos as it assumes power. If the leftists can hold on to their own supporters on the one hand, and convince the industrialists to come to heel or face stiffer political action on the other, they may be able to break past the social and political obstacles to the city's preservation. The engineering is less troublesome; construction of rubber dams or the use of locks to hold back high water have been proposed and both seem relatively practical.

As the Communists prepare to come to national power, the stage is set for new policies that will enable the engineers to set to work. For the sake of Venice one can only hope that the action begins soon. □

O.T.A. Caught in Partisan Crossfire

Colin Norman is a Research Associate at Worldwatch Institute. He was Washington correspondent for Nature *and is a regular contributor to* Technology Review.

The Office of Technology Assessment (O.T.A.) has endured a long, hot summer, and the autumn may not bring much relief. Since it was established in 1973 to provide Congress with analyses of technical issues, O.T.A. has been criticized for a variety of sins of omission and commission. But during the past few months, the Office has been turned into a battleground for partisan politics. Though the dispute has been concerned more with the style of O.T.A.'s operation than with the quality of work, a few serious questions are being raised about the Office's future role and responsibilities.

The trouble began when Emilio Q. Daddario, O.T.A.'s founder and for the past three and a half years its Director, announced his intention to resign. Dr. Daddario had long said that he intended to stay at O.T.A. only long enough to get the Office under way, and his resignation should have evoked neither undue surprise nor cries of foul deeds. Nevertheless, a few days after the announcement William Safire — a former speechwriter for Richard Nixon, now a conservative columnist for the *New York Times* — wrote a column claiming that Dr. Daddario had been ousted by Senator Edward Kennedy (D.-Mass.), Chairman of O.T.A.'s Congressional Governing Board. The move, said Mr. Safire, was prelude to an attempt by Senator Kennedy to "take over" O.T.A. Mr. Safire said Senator Kennedy planned to install his own aide, Ellis Mottur, in the Director's chair and would then use O.T.A. as an extension of his personal staff.

The source of those allegations, it turned out, was Representative Marjorie Holt, a conservative Republican from Maryland who was Vice Chairman of O.T.A.'s Governing Board. Within a week of Dr. Daddario's resignation, Representative Holt also quit, firing off a letter to Senator Kennedy saying that she could no longer have any influence on O.T.A.'s policies because the Board was so dominated by Senator Kennedy and his allies.

A week later, another member of O.T.A.'s Congressional Board, Senator Richard Schweiker (R-Penn.), also resigned. Senator Schweiker said he was quitting simply because his other Senatorial duties had grown and he no longer had time to attend to O.T.A. affairs. Though the move was not inspired by political differences or by concern at the direction O.T.A. is taking, it is nevertheless telling. Senators and Congresspeople are not in the habit of resigning from committees which give them influence or political visibility, and Senator Schweiker evidently felt that the O.T.A. Board provides neither of those attributes.

The third blow fell late in July, when a conference committee finally agreed on a budget bill for the Legislative Branch for fiscal year 1978. The bill included a cut of about $1.6 million in the budget requested for O.T.A., and a decree that the Office's staff should be pruned. O.T.A. will have a budget of just over $7 million next year, about the same as it received this year. The move indicates that O.T.A. has yet to establish its utility to the people who count most on Capitol Hill — the appropriations committees.

Timid and Trivial?

The upsets followed critical reports on O.T.A. last year. The first, from the House Commission on Information and Facilities, said that O.T.A.'s internal management was in a mess and there was a good deal of confusion about the Office's role. That was followed by the resignation of Harold Brown, now President Carter's Secretary of Defense, as Chairman of O.T.A.'s Advisory Council, an independent body which provides policy advice to the O.T.A. Board and Director. In his letter of resignation, Mr. Brown offered some words of praise for O.T.A., but suggested that it had become bogged down in trivial studies and had neglected its primary role of providing Congress with an early warning system on the potential side effects of new technology. In addition, there has been some carping from outside O.T.A. to the effect that the Office has been too timid in its choice of issues and that it has really been providing policy analysis instead of technology assessment.

Before examining those complaints, it is worth reviewing the origins of O.T.A. and its goals.

O.T.A. sprang from discussions in the mid-1960s between Dr. Daddario, then a Congressman from Connecticut and Chairman of the Subcommittee on Science, Research and Technology, and a number of scientists including Jerome Wiesner, President of M.I.T. The basic idea was that Congress lacked the technical expertise to match the Executive Branch on technological issues, and a body to provide technical advice to legislative committees was badly needed. Dr. Daddario translated the idea into legislation, and Congress eventually approved a bill establishing O.T.A. in 1973. By that time, Dr. Daddario had left Congress to make a bid for the Governorship of Connecticut, and he was named the first Director of O.T.A.

The legislation decreed that O.T.A. should be managed by a Congressional Board consisting of six Senators and six Representatives, with equal numbers of Republicans and Democrats. Senator Kennedy was elected the Board's first Chairman; he was followed by Olin Teague, Chairman of the House Committee on Science and Technology, and the chairmanship reverted back to Senator Kennedy earlier this year. In addition, the legislation established an independent Advisory Council to provide policy advice for O.T.A. When Harold Brown resigned from the Council last year, Dr. Wiesner was elected Chairman.

So much for the organizational arrangements. What was O.T.A. supposed to be doing? O.T.A. is a creature of the Congress; it was established to provide advice to Congressional committees when asked, and it must tailor its product to fit the requirements of legislators. This immediately raises a problem, for Congress is usually concerned with immediate issues and requires quick answers, while O.T.A. is supposed to take a long-term view. It is therefore not surprising that much of O.T.A.'s work has consisted of relatively straightforward policy analysis tied to specific pieces of legislation.

In fact, some of O.T.A.'s most widely praised studies have not been technology assessments, according to a strict definition of the term. O.T.A. put together some quick analyses of the Ford and Carter administrations' energy policies which have been credited with eliciting more funds for conservation technologies, for example. It has also produced reports on the bioequivalency of supposedly identical drugs made by different companies, a review of the research and development programs of the Environmental Protection Agency, and a study of computer policies in the Internal Revenue Service. All of those studies were essentially policy analyses but they were the kind of thing that Congress was interested in.

Of the larger studies which conform

"There are few issues on which the Office of Technology Assessment can claim to have had decisive influence."

more closely to technology assessment, only one is significant: a massive investigation of the consequences of expanding offshore oil production along the Atlantic coast, a study which involved considerable public input, identified many potential problems and issues, and attracted a good deal of attention.

Political Spats

So far, O.T.A. has produced more than 40 reports and, though the office has received a lot of criticism, nobody has taken a good look at the products to see whether they have been influential or of reasonable quality. Two such studies are about to be undertaken. First, O.T.A.'s Advisory Council is beginning an investigation of the Office's functions, its impact, and the quality of its work. The study, which was requested by the board at the instigation of Senator Kennedy, has been one of the irritants in the latest round of disputes concerning O.T.A.

The second study will be conducted by the House Committee on Science and Technology this fall. The Committee is planning a series of public hearings at which some of O.T.A.'s critics, including Representative Holt, are expected to testify. The objective, according to committee staff, is simply to review O.T.A.'s record so far, but it is likely to provide a public forum for some of O.T.A.'s critics.

And that brings us to the latest charges that Senator Kennedy is trying to take over O.T.A. Way back in 1973, when O.T.A. was just organized, an article appeared in the *Wall Street Journal* suggesting that Senator Kennedy was about to use O.T.A. to build up his power base for the 1976 Presidential election. Should the latest accusations be given any more credence?

Senator Kennedy certainly dominates O.T.A.'s Congressional Board. His views usually carry the day, and on the few occasions when there has been a vote on a major question, the majority has sided with Senator Kennedy while the dissenters have been Representative Holt, her two fellow House Republicans, and Olin Teague. One reason why Senator Kennedy has been so influential is that he is perhaps the most active and interested member of O.T.A.'s Board (witness, for example, Senator Schweiker's statement that he no longer has time for O.T.A. affairs). But Senator Kennedy's critics charge that his influence stems chiefly from another source: he has some of his own staff aides working for O.T.A., and he has close connections with Dr. Wiesner.

In fact, most of the Senate members of the O.T.A. Board have some of their own staff aides working for O.T.A., a situation which has raised complaints from a few other O.T.A. officials, who see the political appointees as inconsistent with O.T.A.'s supposedly non-partisan role. As for the complaints about the link between Senator Kennedy and Dr. Wiesner, Dr. Wiesner was not appointed by Kennedy (contrary to some published accounts), but was elected by other council members. The election, moreover, took place when Representative Teague, not Senator Kennedy, was Chairman of O.T.A.'s Board.

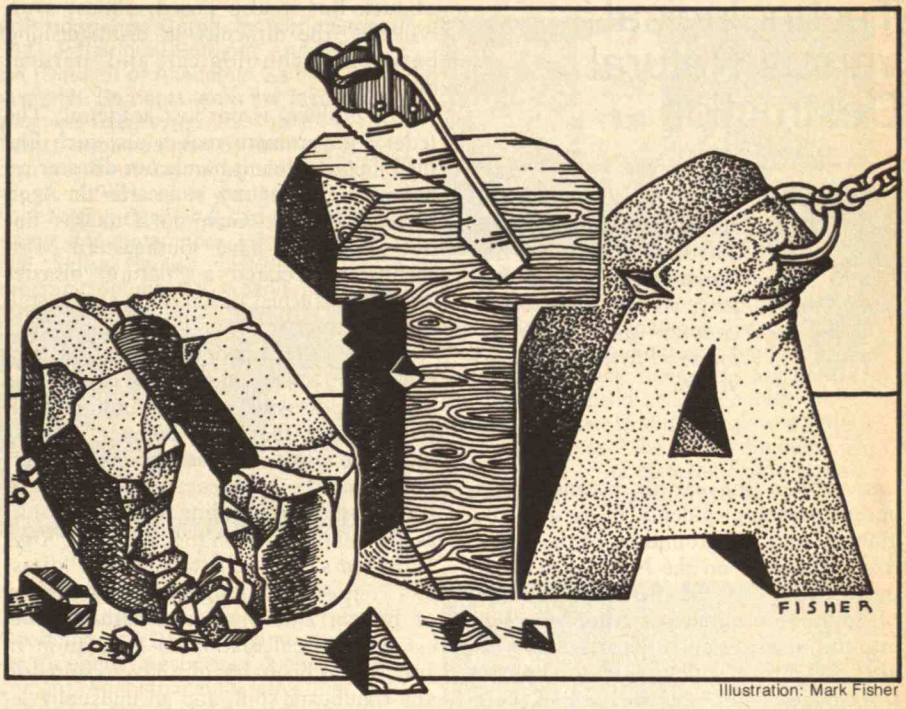


Illustration: Mark Fisher

Another possible reason for the dispute over Senator Kennedy's role is pure partisan politics. Senator Kennedy, a liberal Democrat, is always a prime target for conservative Republicans, and this case is no exception.

Representative Holt's resignation followed three differences of opinion with Senator Kennedy on O.T.A.'s Board. The first concerned a vacancy on the Advisory Committee. J. Fred Bucy, an executive of Texas Instruments, was up for reappointment to the Council but Senator Kennedy objected, criticizing Mr. Bucy's record of attendance during his first term of office. Representative Holt charged that Senator Kennedy's objections stemmed from differences of opinion on several matters of policy. The second irritant was Senator Kennedy's proposal that the Advisory Council should conduct a review of O.T.A.'s operations, a review which Representative Holt believed would be biased because of the Council's alleged close links with Senator Kennedy. And third, Representative Holt objected to Senator Kennedy's proposal that O.T.A. should do a quick study of the data which led to the proposed ban on saccharin. Representative Holt said that the review would add nothing to the debate and charged that Senator Kennedy only wanted a study which would support his own position. Representative Holt was defeated on all three issues, and subsequently resigned from the Board.

All of these spats mask the central question about O.T.A.: is it performing useful functions, and is it having any impact on congressional operations? O.T.A. staffers point to a stack of press clippings and comments from members of Congress praising its work, but there are few issues on which O.T.A. can claim to have had decisive influence. The reviews by the Advisory Council and the House Committee on Science and Technology should, however, provide some real information on the quality and impact of O.T.A.'s operations — though there is also the danger that the House Committee hearings may degenerate to yet another exchange of partisan rhetoric.

Meanwhile, a replacement for Dr. Daddario as Director of O.T.A. is being sought, and an appointment is expected soon. □

Technological versus Natural Destruction

Robert Finch is Editor of the Cape Naturalist, *the magazine of the Cape Cod Museum of Natural History, and writes a regular column of "Soundings" for the* Provincetown Advocate.

Last winter, the earth's oceans experienced a seeming epidemic of oil spills, beginning with the grounding of the tanker *Argo Merchant* on the Nantucket Shoals on December 15 and the subsequent loss of 7,600,000 gallons of crude oil cargo into the North Atlantic. Nearly each week after that a fresh spill was reported on our front pages — in Chesapeake Bay, Long Beach, Hawaii, the Bahamas — until after a while they seemed as routine as the Sunday crossword puzzle. They became something of a fad, complete with jokes about "oysters Rockefeller," and refining seawater, perhaps because many of us needed to find something to laugh about during the periods of extreme cold that gripped much of the nation.

With the coming of spring the oil spills gradually "went away," just as the initial energy crisis "went away" three years ago (though those of us who live near the shore do not expect we have seen the last of clean-up crews and befouled seabirds). Other news has supplanted them in the headlines, and scientific attention is now focused, as it should be, on such areas as the monitoring of ocean sediments and the study of suspected changes in the behavior of lobsters and other petroleum-affected species.

However, other questions raised by the spills have received little attention. One was dramatized by a newspaper photo which, for me, remains the most striking image of the entire, oily winter. It showed enormous black plumes of smoke rising up from the frozen white surface of Buzzards Bay, at the south entrance to the Cape Cod Canal, as the Coast Guard attempted to burn off some of the 100,000 gallons of No. 2 heating oil that leaked from the grounded barge *Bouchard No. 85* on January 28. That picture captured the winter's irony: spilled oil burning on the ice while factories and schools shut down in Ohio and Pennsylvania for lack of fuel. But it also posed, almost symbolically, the difficulty in distinguishing between technological and natural disaster.

The problem is not just academic. The federal government makes just such fine distinctions when it hands out disaster relief money, as we saw soon after the *Argo Merchant* wreck. Governor Dukakis' initial request to have southeastern Massachusetts declared a "natural disaster area" was turned down because the spill was "man-made."

On the other hand, the city of Buffalo, buried in snow, quickly received the "natural disaster" designation. But it seems to me that this "disaster" was as much the result of human error (of underestimating the chances and the punch of such a winter, and failing to prepare for it) as any delinquency on the part of the *Argo Merchant*'s captain. After all, both "disasters" represented unforeseen conjunctions of human enterprise and natural processes. A miscalculation in navigation in July would probably not have resulted in any significant spill, and an unusually severe snowstorm in upper Labrador would hardly have rated any headlines.

Yet though governments and the media make such distinctions, it is often not so easy to explain our different reactions to the effects of human and natural destruction. Why are we more distressed to hear of thousands of fur seal pups slaughtered and skinned by pelt hunters in Newfoundland, than we are by the thousands of pups slowly dying on the rocks from hookworm infestation? And why are we more likely to see pictures of one in our papers than the other?

Not too many months ago the death of 15,000 sea herring at the entrance to the Pilgrim Station Atomic Energy Plant in Plymouth, Mass., received wide attention in the press, and rightly so. Yet last fall, our interest in the stranding of millions of long-finned squid on the beaches of Cape Cod Bay lapsed once chemical pollution was ruled out as a cause.

Who Says Nature Is Kind?

Mortality is the rule in nature, and we tend to accept it, perhaps unconsciously, with indifference or philosophical acquiescence — as long as it doesn't touch our own interests too directly. On the other hand, human-caused destruction in nature tends to raise our hackles.

The juxtapositions frequently seem designed to confound us, especially in a place like Cape Cod which is so vulnerable to both human and natural forces. Our tern colonies, which find their nesting sites on low, exposed beaches, are annually threatened by motorboats, beach buggies, and foot traffic. Yet hundreds of these tern chicks are also baked to death each year in the summer sun, or swallowed in the rising gorge of a summer storm, or are decimated by a few great-horned owls. Last winter the Cape Cod Museum of Natural History treated some two dozen murres, auks, and other pelagic birds that had been stained by assorted oil spills. And just the other week, walking an isolated strand of barrier beach, I found the carcass of a brant that was emaciated, oil-stained, and viciously decapitated. To what was I to chalk up this death: ice, oil, dogs? Where, after all, does man leave off and nature begin?

Some (who would use the undeniable magnitude of natural destruction to explain or justify our own) suggest, for instance, that depleted fish stocks are as much the result of natural population cycles as of overfishing. They imply that we have just as much right as nature to destroy, and what is all the belly-aching about anyway? Who says nature is kind?

Others, frightened by the apparently burgeoning effects of human technology and numbers on the world, seek to quarantine us from the environment like an unnatural infection. Yet we cannot, even if we would, live like a flock of sanderlings, running perpetually along the surf-edge of the world, nimbly picking up our nourishment without getting our feet wet. Even if there were a way to quarantine ourselves we could not do it. People need and demand participation in nature. Without it we atrophy.

If we concede that it is frequently difficult, if not impossible, to distinguish between natural and human destruction, is there any basis on which we can make a useful distinction? I find a possible answer in the current trend among environmental groups away from so-called "focal-point" conservation. These environmentalists are less interested in saving specific endangered animals or sites — whooping cranes, red wolves, Franconia Notch — than in a broad effort to protect and conserve entire systems of natural processes. By emphasizing processes rather than places or populations, we begin to recognize the source of all natural health and abundance, without which no bird or forest would exist. We are learning that, in the long run, it is more important to protect the larger, creative processes of nature — ocean currents, sand transport, marsh development — than, say, a particular stretch of beach or flock of birds which may be only transitory and purposefully vulnerable parts of the whole.

Continued on p. 23

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Trend of Affairs

New Heat in Climate Prediction

Warnings of climatic change arrive as regularly as the seasons, but their content is far less predictable than seasonal weather. The situation was different this summer. There were plenty of predictions, as usual, but two of them, from two prestigious forecasters using predictive atmospheric models, were unusual in their unanimity. Average temperatures on the earth, both said, are likely to increase by up to 11° F. in the next century if we continue to burn fossil fuels — especially coal — at growing rates.

The temperature increase will result from the well-known "greenhouse effect." Water vapor and carbon dioxide, released into the atmosphere when fossil fuels are burned, absorb and re-emit infrared radiation. Thus they trap solar heat inside the earth's atmosphere, just as heat is trapped inside a glass greenhouse. Even now the greenhouse effect is at work in the atmosphere: the average global temperature is normally about 10° C. higher than it would be without that insulation.

The summer's two reports — from the National Academy of Sciences, which issued the results of a two-and-a-half-year study in July, and from Wallace C. Broecker, the recognized authority on the carbon dioxide problem from the Lamont Doherty Geological Observatory — say that if the carbon dioxide content of the atmosphere were to double, the average global temperature would increase between 4° and 5° F. Such a CO_2 doubling is within the realm of possibility. Since the beginning of the industrial revolution alone, the burning of fossil fuels has raised the CO_2 level about 13 per cent. "It is not implausible," says the N.A.S. report, "that the peak atmospheric concentration occurring in A.D. 2150 to A.D. 2200 might be four to eight times the preindustrial level."

The effects of such a dramatic rise in temperature are almost beyond imagination. Farming would move north; instead of a corn belt in the midwest, for example, there would be a corn necklace reaching across Saskatchewan. The more northerly soils are acidic, so crop yields would certainly go down. New England fishermen would find their cod off Greenland instead of Nova Scotia. Ships could navigate the Northwest and Northeast passages in the dead of winter.

Polar ice caps would begin to melt. As a result, oceans would rise — about one meter for every 5° C increase in temperature, says the N.A.S. report. Some 80 per cent of the world's great cities are located on oceans; at the very least, waterfront parks would become waterfront swamps.

Other effects are difficult to predict. While increased CO_2 poses no health hazard, changes in local rainfall and temperature patterns would lead to changes in lifestyles. Energy for heating would go down but that for cooling would increase.

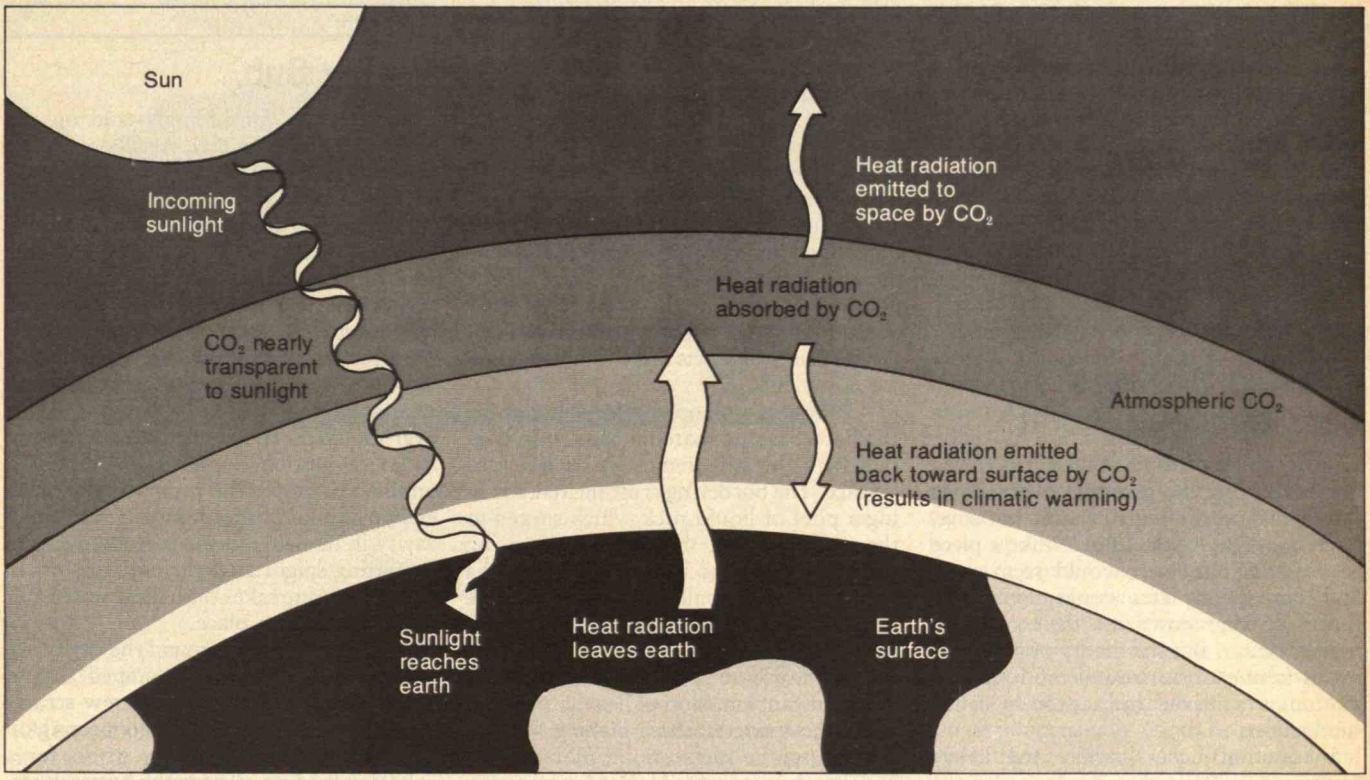
To understand the future, look at the past, says Dr. Broecker. Analysis of ice cores from Greenland and Antarctica and sediment cores from the oceans tells him that the temperature difference between the last glacial age (20,000 to 16,000 years ago) and the last period of warm-up (3,000 to 6,000 years ago) was by only 4° F. If we warm the earth by only 4° F, "We will have succeeded in making a change about half as large as that which occurred when the great ice sheets which covered virtually all of Scandinavia and Canada shrank to oblivion," he says.

The implications of any future coal-based economy are enormous. Burning a ton of coal releases three tons of CO_2, and attempts to prevent pollution from coal add to the CO_2 load: most pollution controls oxidize intermediate combustion products such as CO and hydrocarbons to CO_2. While we can eliminate poisons and particulates from stack gas, no obvious way to screen smokestacks for carbon dioxide has yet been found.

Coal is abundant enough to provide the world with most of its energy until the end of the next century, says the N.A.S. report, even anticipating a world population of 10 billion people using five times our present energy consumption by the year 2100. If Dr. Broecker is right, such a coal-based world economy would be adding its CO_2 to the atmosphere just as the earth's natural 80-year cooling cycle is reversing, so that combustion-induced heating will reinforce a natural warming trend. In even as little as 22 years, by 2000, the earth could already average 0.5° C. warmer, and "that's enough to buy us conditions warmer than we've experienced in the last 2000 years."

Such a dramatic scenario is not inevitable. The use of nuclear, solar, or other non-fossil energy sources would be a solution for industrial economies. And there is still a large portion of the world whose energy needs are still met by wood. But over-use of wood and other biomatter may compound the CO_2 problem.

Carbon dioxide is the cause of the "greenhouse effect," in which CO_2 absorbs and re-emits a significant portion of the heat the earth receives from the sun. Without CO_2, much of this solar energy would pass through the atmosphere into space.



Sixty per cent of the carbon dioxide now released into the atmosphere by the burning of fossil fuels is absorbed by natural sinks: 40 per cent by trees and plants through photosynthesis, and 20 per cent by the oceans through reaction with carbonate ions in sea salt. But as population grows, more land is cleared for agriculture and more wood cut for fuel, particularly in the plant-rich tropics, the natural sink for 40 per cent of our excess CO_2 shrinks. The oceans' ability to absorb CO_2 may also be reduced if our climate suddenly grows warmer: warmer temperatures could create a warm-water lid over the oceans, which would prevent the mixing that normally brings deep water not saturated with CO_2 to the surface. With the effectiveness of these natural CO_2 sinks reduced, the climatic changes would be long-lasting, says Dr. Broecker. Atmospheric concentrations of CO_2 would rise immediately as fossil fuels are burned, but even if CO_2 inputs were then suddenly reduced, atmospheric CO_2 would be taken up by plants and oceans at decreasing rates, for a few thousand years before a new balance is achieved.

However, the model on which these predictions are based does not include changes which may counterbalance its dire prospects. Many of the earth's processes of heat transfer are simply blind spots to scientists. The most important among these is the cloud factor. The N.A.S. group estimated that a 7-per-cent rise in global precipitation would accompany a 4-per-cent rise in average temperature. Increased cloudiness would be inevitable; but whether the clouds would be heavy enough to provide the earth an umbrella and counteract the "greenhouse effect" is unknown.

Also unknown is the effect of higher temperatures on the antarctic ice sheet. The West Antarctic ice sheet is only partially grounded. It might disintegrate over a few hundred years, thus raising the level of the ocean by 18 ft. and throwing calculations based on sea mixing rates and land/sea areas to the wind. "We're not at the point in our modelling to make quantitative estimates," Dr. Broecker reports.

"The ideal model would mock-up the whole world atmosphere," he says, "and include information about the physics of clouds, regional rainfall predictions, and the effects of oceanic heat transfer from pole to equator." Unfortunately, neither meteorological data nor computer capacity are yet sufficient for such an effort.

"But the predictions are not useless," he asserts. It is clear, he says, and the N.A.S. agrees, that mean global temperatures would rise significantly in concurrence with added CO_2; thus even today's simplest models, with all their faults, function as an early warning system.

What are our alternatives? Reduce fossil fuel combustion by reducing energy consumption and by turning toward nuclear and solar power. The N.A.S. study proposes that a thin coat of latex spread over large areas of the ocean — an impractical if intriguing vision — could increase the ocean's ability to reflect, rather than absorb, sunlight. A more practical solution may be to increase the earth's plant life to provide a larger capacity for CO_2 in the biosphere, where it was stored in the first place. Doubling the mass of living trees would take care of a third to a sixth of the CO_2 that might be added to the air from fuel combustion. "Tree farms" might be planted for this express purpose. But, the N.A.S. study adds, if these new forests were to be grown, why shouldn't the trees be used for fuel, and the fossil fuel spared?

Research solutions are clearly the key at the present time. All the gaps in the model mentioned by Dr. Broecker need to be filled; new burning methods for fuels or "scrubbers" for CO_2 to be developed; and, most importantly, alternative methods of generating energy must be explored.

The N.A.S. does not want its report read as another warning of an impending doomsday; its goal is simply to "engender a lively sense of urgency" from which will come new research and wider understand-

ing. It has been seen as such already; following the release of the N.A.S. report, the Energy Research and Development Administration established an office, using funds set aside for that purpose in President Carter's energy plan, to investigate the potential environmental impacts further. — *S.J.N.* □

Asteroid Showers Set Continents Adrift

Like the cracked pieces of shell enclosing a soft-boiled egg, the giant plates that form the earth's crust cling to a soft, hot core. Each fragment nestles in place like a piece of a jigsaw puzzle. It would seem then, that these great plates would merely bob gently up and down on their common molten center. But the theory of plate tectonics is one of horizontal motion. This motion is achieved by a process called subduction.

Subduction occurs where the heavy plates underneath the oceans meet the lighter continental plates. At that juncture, in the ocean trenches, the heavy ocean plates dive beneath the continental plates. The volatile elements they take with them are expelled through volcanoes which flank the trenches. Plates are renewed at spreading centers under deep sea ridges. The continental plates also move toward the trenches but, too buoyant to be sucked under at the subduction zones, continue to drift on the surface.

The earth was not always so. Four billion years ago, the surface of the molten earth cooled to form a uniform basaltic crust. What, then, cracked the egg and began the plates' horizontal movement?

Plate tectonics were triggered by the same showers of asteroids that pitted the moon's surface, says N.A.S.A. scientist Herbert Frey. He explained his hypothesis, which is based on the theory of the common evolutionary history of the terrestrial (Mercury through Mars) planets, to the American Geophysical Society in Washington, D.C., this summer.

The process is somewhat complex:

□ About four billion years ago, the earth and other terrestrial planets were bombarded by showers of asteroids which had been deflected toward the sun by Jupiter's immense gravitational force. These asteroids, says Dr. Frey, were large — about 30 miles in diameter — and fell upon about 50 per cent of the earth's surface.

Dr. Frey says that the moon, whose impact-generated craters are easily observed, experienced bombardment on 40 per cent of its area. He derived his numerical estimates by scaling upward for the earth's greater surface area and stronger gravitational pull.

□ The asteroids landed, with gigantic impact, blowing material from the hard surface and fracturing the rocky crust to its molten interior. The entire area indented under the impact. These compounded areas of impact were to become ocean basins; the areas which did not experience such impacts were to become the dry continents.

□ Underneath the newly formed craters, the hard basaltic material came into contact with the still tremendously hot subsurface. The bordering crust melted, forming a pool of liquid rock which surged to the surface along the fractures, causing further melting as it rose. This magma source at fairly shallow depths is unique to earth, says Dr. Frey: the faster cooling crust of the moon was too thick for magma flows to penetrate the surface. This constant emission of heavier material sunk the craters, thus making further changes on the surface.

□ Thus two types of crust were established. As the process was completed, the earth's moving molten center, set in motion by the spin of the earth, put pressures on the junctions between the high continental area and the low-lying crust that had been covered with heavy lava. Subduction, which originally occurred at the interface of the continent basin regions, was established.

"With subduction established, sea-floor spreading at mid-mare ridge could begin the long processes of oceanic crustal reworking," says Dr. Frey. This explains why the sea floors are geologically much younger than the continental regions.

Without asteroidal bombardment, says Dr. Frey, the earth's history would be very different. "Without subduction there would be no spreading" of the earth's surface, and great mountains created by the collision of crustal plates, such as the Himalayas, would not exist.

"There would have been a somewhat more distressing implication for the evolution of life," he adds. Without the formation of large basins where water could collect and remain, the processes of chemical evolution, which were the cradle of life on earth, would probably not have occured. Without volcanoes spewing molecules of volatile elements necessary to life, and without the oceans providing flows of heat from equator to pole, life on earth would look very different than it does today. — *S.J.N.* □

TRANSPORT

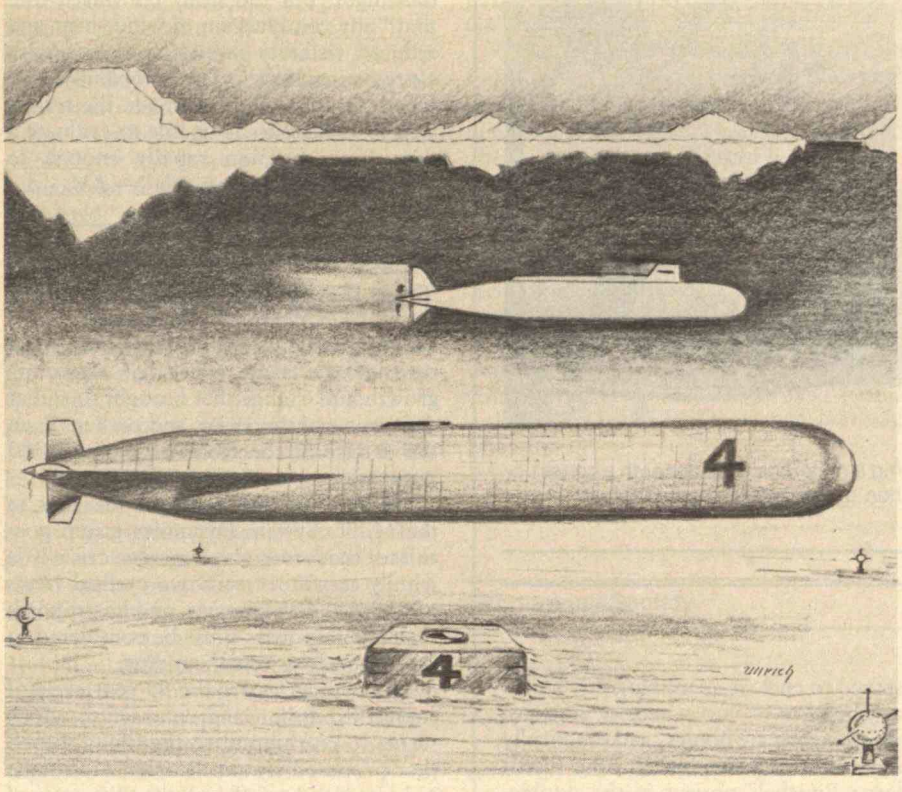
Tanker Sub

It is dark and forbiddingly cold on the bottom of Prudhoe Bay, Alaska, and one would expect it to be deathly quiet. But it isn't — a powerful rush of water marks the approach of a massive underwater shape. Guided by under-shore computer control, a thousand-foot-long submarine tanker makes its approach to an underwater terminal to take on another load of Alaskan oil bound for the eastern U.S. Slowly the submarine, shaped like an enormous, squared-off torpedo, edges over the dock, its side thrusters adjusting its lateral motion. Sonar sensors mounted on the bottom tell the computer the tanker's position and speed. Finally, the small cavity in its belly hovers directly over the projecting spigot atop the undersea dock. The submarine takes on ballast water and settles firmly into place.

After sealing rings around the cavity are inflated and the cavity pumped dry, a hatch opens, and the tanker crew scrambles into the cavity to begin connecting oil and ballast hoses. The crew works for a solid day loading oil onto the huge tanker, adjusting ballast tanks for neutral buoyancy and cleaning up minor oil spills within the cavity. Meanwhile other submarine tankers have also made approaches to nearby docks to begin taking on cargo.

Finally loading is complete, the cavity is flooded, and the tanker edges away from the dock. Safely away from the dock, the shore computer relinquishes control, and the captain, once more master of his ship, guides it under the Arctic ice pack. Sonar beams watch the ice above, the bottom, and the path in front of the tanker for stray fingers of ice jutting into its path. The submarine, powered by a huge nuclear generator, makes a steady 20 knots, cruising at a depth of 700 feet around the northern tip of Greenland into the North Atlantic. The sonar also scans for openings in the ice, should the submarine need to raise to snorkel depth or surface for an emergency. Inertial navigation keeps the submarine on its course, and it communicates with the shore via bottom-mounted communication buoys.

On the long voyage, the crew is comfortably ensconced in roomy cabins, unaware of the huge oil and ballast tanks surrounding them. They are certainly not worried about collisions, for the sub cruises far below the Arctic ice pack and surface ships, and well out of shipping lanes on a cruise path reserved for the tankers' use.



The proposed tanker sub would compete economically with surface tankers and pipelines, say its designers. The size of the tanker sub is shown above in comparison with a conventional naval nuclear submarine. (Drawing: Robert Ullrich)

After making slow-but-steady progress into southern waters, the submarine reaches its underwater loading port off the Virginia Capes. Again a shore-based computer takes over the approach, and again the submarine settles precisely over the dock, its belly cavity again evacuated and its cargo unloaded. Two million barrels of Alaskan oil have been delivered to the oil-hungry eastern United States.

According to two engineers at Newport News Shipbuilding, the above scenario is no mere fantasy, but a technically and economically feasible solution to transporting Alaskan and Candian oil to the high-use areas of the eastern U.S. In a paper for the Offshore Technology Conference last spring in Houston, P. K. Taylor and J. B. Montgomery declared that a system of enormous, nuclear-powered submarine tankers could compete economically with both pipelines and icebreaker-tankers plying a northern route to the east coast. What's more, they said, the submarine tankers would operate more reliably and with less ecological risk than either surface tankers or the controversial pipelines. The system would be totally sealed from the marine environment during loading and unloading, and water used as ballast would be piped ashore for treatment. And of course, the submarines would be immune from the violent storms which have produced so many surface tanker spills.

According to the two engineers, the technology is already firmly in hand, and a submarine tanker fleet could be developed and operational in about ten years. Only slight modification would be needed to a currently available commercial nuclear steam power system to make it suitable for a submarine tanker, they said. And the extensive military experience with nuclear submarines has proven the reliability of nuclear-powered undersea vessels.

As to economics, the engineers calculate that a fleet of submarines shipping directly from Alaska to Virginia, a likely off-loading point because of the proximity to refineries, could move the oil for about $3.60 per barrel. This compares with a Trans-Canadian pipeline cost of $4.47 per barrel, and an ice-breaker-tanker shipment cost of $3.08. A cheaper submarine system, costing about $2.64 per barrel, would involve off-loading the oil from the submarines onto surface vessels at Norway, and then shipping it to Virginia.

Little interest has been shown in the submarine system, said the two authors. "In the general sense 'new ideas' frequently meet 'cold receptions' and since the submarine tanker system has never been tried it is 'new' simply by definition."

The engineers also cited critics' concerns over the system's high specialization: "A valid question, but one which also might be asked concerning the Alaskan pipeline."

However, said the report's authors, their systems analysis of the submarine shipment method reveals it is a viable alternative, and one which they hope will receive further serious consideration. — *Dennis Meredith* □

Storm-Tossed Mock-Ups

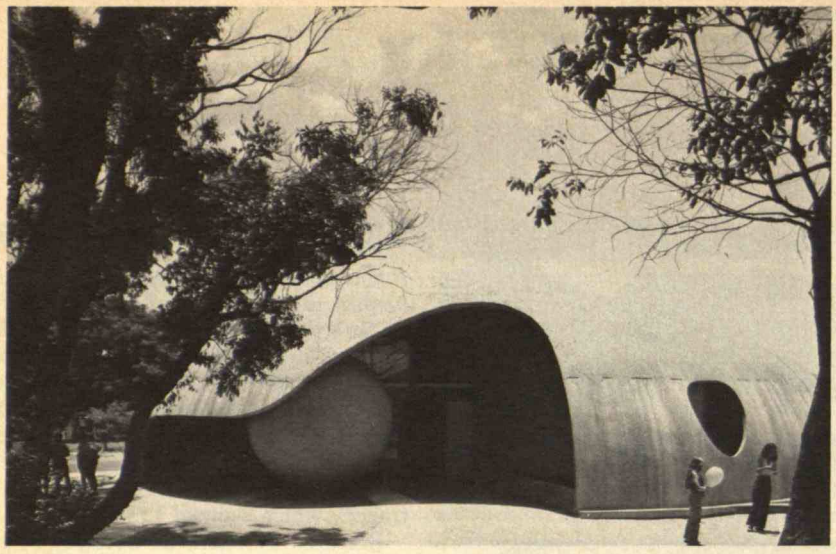
A thunderstorm was drenching Kennedy Airport the afternoon of June 24, 1975. At 3:48 p.m., Allegheny flight 858 landed safely. Ten minutes later, as the thunderstorm intensified, Eastern 902 successfully executed a "missed approach," abandoning its effort to land at Kennedy. Only seven minutes later, at 4:05, Eastern flight 66 crashed short of the runway — a tragedy which claimed 113 lives.

Research by Mark E. Connelly of the M.I.T. Electronic Systems Laboratory shows why this was such a devastating situation.

He set out to present a 707 aircraft simulator with conditions similar to those at Kennedy Airport that afternoon — vigorous thunderstorm cells containing both updrafts and downdrafts moving across a runway approach. Then he invited ten experienced commercial and military pilots to fly the simulated 707 in the Electronic Systems Laboratory through his computerized thunderstorm. Deprived of acceleration and visual cues which pilots usually use to help them land under these difficult conditions, the test pilots brought their simulated aircraft in for unsafe landings — short, long, or off the edge of the runway — 65 per cent of the time.

Here's what happens to a pilot attempting to approach a runway through a thunderstorm, according to the M.I.T. simulations: In its simplest representation, a thunderstorm consists of a central downdraft of cool air (with a velocity of as much as five or six meters per second) surrounded by an updraft of warm air whose velocity may be one or two meters per second. The entire storm moves at speeds ranging from five to ten knots. A pilot approaching a runway under these conditions first encounters a sudden updraft which pushes his aircraft above its proper alignment and increases the angle of attack; the pilot counters this by cutting down power and lowering the nose. Then comes what meteorologists call a horizontal shear — a sudden change from updraft to downdraft. Suddenly the aircraft is too low, and its angle of attack too steep. The harried pilot must reverse his earlier response, and immediately increase his plane's angle of attack and engine thrust.

When these conditions are encountered within 700 feet of the runway, much of the action occurs with the aircraft 200 feet or less above the ground — the elevation below which instrument landing systems are considered "unusable." So pilots must rely on what they can see on the ground for clues as to the position and movement



A building in Sydney, Australia, produced by the Binishell method, involving inflating a neoprene liner beneath a construction of steel-reinforced concrete.

ARCHITECTURE

Blowing Up Buildings

A dome is a marvelous architectural idea, unless you have to build one. While domes offer spacious interiors and economy of materials, they also offer construction headaches. Many sections must be fitted together, there are leakage problems at their numerous joints, and they are structurally weak until completed.

An Italian construction firm appears to have solved many of these problems by making dome construction literally as simple as blowing up a balloon. The technique was reported in the November/December, 1976, issue of *DuPont Magazine*.

The "Binishells" (named for inventor Dante Bini) are constructed by pouring concrete over the top of a Neoprene liner covered with a reinforcing spiral steel mesh. Another liner is spread over the top of the concrete and air is pumped underneath this sandwich to inflate the material, and lifted into the desired dome shape. After about 36 hours the concrete has set, and the internal liner is deflated and removed. Windows and doors are cut with a circular saw, and the outside is waterproofed with a bituminized felt coating, covered by acrylic resin paints.

The technique allows domes to be erected with remarkable speed, said Alberto Michelagnoli, general manager of Binishells S.P.A., of Milan, Italy. Four people can erect a dome 11 meters high and 36 meters in diameter in just four normal workdays. More than 300 Binishell buildings have been erected in France, the United Kingdom, North and South America, Japan and the Middle East. The buildings have served to enclose swimming pools, and as churches, schools, service stations, theaters, private homes, and practically any other use imaginable. One recent large Binishell project is the double-domed sports hall in Turin, Italy. Two domes, each 36 meters in diameter, were formed and joined in the middle where they overlap. The result was a hall which could accommodate up to 2,000 spectators for basketball, boxing or other sporting events. The dome's thickness varies from 12 centimeters at the base to about five centimeters at the top.

The dome construction system has its problems. "At first inflation was uneven, and this led to concrete slippage. After three years of experimentation, we solved the early problems by introducing the steel mesh reinforcement, designing high frequency vibrators for compacting the concrete, and using a computer to calculate precise positioning and control data," said Mr. Michelagnoli.

Architects have discovered problems with the technique, but term them minor in comparison with the advantages. According to Milan architect, Mario Panciroli, the system has only one minor drawback. "While it's easy enough to cut door and window openings, there's some difficulty in cutting them with real precision," he said. "But overall, Binishells represent a significant advance in technology and is less expensive than any other construction system that I know of for permanent buildings." — *Dennis Meredith* □

of their aircraft. These are normally adequate, and Mr. Connelly says their use makes the difference between the pilots' bad records in his simulated cockpit and the airlines' relatively good records in actual flight. But the study convinced him that "any combination of wind shear and reduced visibility should be treated with extreme caution." The problems arise when "a pilot who has made the transition to visual cues is unable to evaluate a dangerous situation rapidly enough to execute a missed approach."— *J.M.* □

ENERGY

The Energy Cycle

Today's "energy crisis" could be the latest turn of the same wheel of economic growth and change that brought the great depression of the 1930s and perhaps even the demise of the Roman Empire 2,000 years ago.

Jay W. Forrester and his colleagues in the M.I.T. System Dynamics group postulate that today's "energy crisis" is wholly consistent with two cyclical views of national development, and he proposes that our responses must be considered in the light of this understanding.

The two cycles are the 50-year cycle of capital expansion and contraction which seems to correspond to the "long wave" first proposed by the Russian economist Nikolai Kondratieff, and the "life cycle of growth" — the process in which a nation's population and industrialization grow until constrained by environmental limits. Professor Forrester's *World Dynamics* and Dennis L. Meadows' *Limits to Growth (see "Modeling Cycles in the National Economy," by Nathaniel J. Mass, March/April, 1976)* were based upon computer models of these cycles.

It is no accident that each of the last three 50-year Kondratieff cycles coincides with a transition in our principal energy resource: from wood (1830-1880) to coal (1880-1930) to oil (1930-1980). The Kondratieff cycle is moved by capital expansion and contraction, Dr. Forrester told an international symposium sponsored by the Sperry Rand Corp. last spring, and so it has "the capacity to bunch and compress technological change."

As we near the end of the "oil cycle," Professor Forrester advises us to plan now for our next great cycle of capital growth. Our inability to formulate an effective energy policy arises from "trying to build on a past that cannot survive, while looking no more than a decade or two into the future" — a future that shows clearly only the decline of the present system.

"Guidance lies further out," he said. "We must look across the 50-year valley, perceiving the structure of the future . . . We must think in terms of a society with energy of a different kind, built around a new infrastructure of technical support systems and social relationships." — *J.M.* □

Oil Recovery Beyond the Fizz

Early oil explorers were content to extract only the "fizz" from their wells — only the oil forced to the surface by the pressure of natural gas in the oil. Eventually they learned that by injecting water or gas into the well they could force even more oil from their wells.

But dwindling oil resources have led to research on still more sophisticated technologies for squeezing oil from even these "depleted" reservoirs. In a symposium at the recent annual meeting of the Annual Physical Society, oil researchers reported their prospects.

The target resource for enhanced oil recovery is enormous, said participants in the symposium. With today's extraction technology, about 70 per cent of the oil in place in a deposit stays in place — about 300 billion barrels of oil. About 100 billion barrels of this oil is extractable by enhanced recovery techniques — meaning it is not so tightly enmeshed in the rock pores of underground reservoirs that it could not be coaxed out. If 30 per cent of this oil could be recovered — a safe bet, said the researchers — this would mean 30 billion additional barrels of oil.

Extracting this oil is a technological challenge. It is trapped tightly in microscopic pores in underground rock, held by capillary forces and interfacial tension; the same forces hold water in a paper towel, for example. Researchers have found two basic removal methods — heating or treatment with a chemical that releases the oil from the rock pores. For high-viscosity oils, an injection of steam, or even ignition of some of the oil underground to liquefy the rest has proven useful. The other major extraction technique involves injecting chemicals such as dry-cleaning solvents, alcohols, detergents, or carbon dioxide into the well to dissolve the oil out of the pores or reduce its surface tension such that it flows out. Usually injection is done through one well or group of wells in a field, driving the oil out of the underground rock toward another well.

Although the chemicals used for injections are highly effective — one volume of chemical driving as much as 30 volumes of oil — they are also expensive. However, scientists have discovered that the chemicals can also be highly effective if a slug of chemical is injected into the well, followed by injection of a driving fluid such as brine. A major problem to be solved by both laboratory and field studies is that the slug of chemical sometimes breaks into "fingers," intruding into the oil deposit and bypassing large quantities of oil. So, while laboratory results indicate that up to 90 per cent of "tertiary" oil could be recovered from a well by chemical injection, field tests have reached only about 60 per cent.

Oilmen pointing to the promising preliminary results argue for price supports and guaranteed loan programs to encourage oil recovery through these advanced processes.

"All of the infrastructure for enhanced oil recovery — pipelines, refineries, etc. —is in place and the environmental impact is relatively nil," said Arnold Goldburg of Gary Operating Co.

"Compared to the other alternative fossil energy resources, synthetic fuels and shale, enhanced recovery has the highest benefit/cost ratio. . . . None of the other alternative energy resources has its infrastructure in place, which means that their real costs are presently unknown."

Dr. Goldburg pointed out that all too often the label "far-term" applied to a technological process is a synonym for "unlikely." Thus, he expressed doubts that such far-term technologies as shale oil extraction or synthetic fuel manufacture could ever be as feasible as "near-term" enhanced oil recovery. — *Dennis Meredith* □

Technology/Society

Continued from p. 5

been able to recover from my broken rib.

Just what is the optimum throughput, however, is a very tricky question. Many people argue today that impending energy and material shortages compel us to concentrate our research on increasing durability. Up to a point this is clearly desirable. But beyond a certain point we buy durability at the cost of flexibility and powers of healing.

A general evolutionary principle has it that beyond a point efficiency is a sure recipe for extinction. A species that is too efficient expands to the full capacity of its niche, and when catastrophe hits and affairs worsen (as eventually they always do), the species is wiped out. We ought to be careful when we moralize about waste. Some waste is justified, even necessary, just as some pollution is necessary — unpleasant as these propositions may be to the purist. We must be sensitive when we assess where these optima lie; otherwise the search for perfection may drive us to extinction. □

Special Report

Continued from p. 16

Human Abstractions

Technological and natural destruction cannot be distinguished on the basis of their immediate, observable effects. Even the term "destructive" is largely subjective: one man's beach is another man's erosion. The critical difference is that any natural force is linked to a myriad of other

forces around it, physically, intimately, and immediately linked. Every natural process is part of an unbroken web or matrix of connected events, accountable to and cooperative with each other. This is true of an avalanche roaring down a mountainside (perhaps wiping out an alpine village with it), or a bluefish chopping its way through a school of mackerel (perhaps taking a lure in its blind greed). "Destruction" in nature — whether of a beach, a school of fish, or even an entire ecosystem — is characteristically a necessary part of a larger, balanced system of natural processes.

Not so with human disruptions in a highly technological society. What distinguishes our destruction is its characteristic *separateness* from what it destroys, its lack of interaction, dependence or accountability towards what it affects. What, after all, steered the *Argo Merchant* onto the treacherous, fog-shrouded shoals? What pushed the beach buggy up onto the fragile dune and into the vulnerable tern colonies? What brought the nuclear power plant to the shores of Plymouth?

The answer is human abstractions: abstractions in the form of international finance, flags of convenience, corporate planning, economic trends, and recreational fads. Add to these our singular ability to transfer large amounts of energy from one place to another without a physical accountability, a balancing of forces, at either end.

This is why, I think, a disaster like the *Argo Merchant* spill holds such terror for those of us who live near it and learn something of its nature. It was not just the hundreds or perhaps thousands of seabirds that died from pneumonia or internal poisoning, nor the possible eventual harm to shellfish and fish populations, nor the loss of revenue to fishermen, or to motel owners if the sticky stuff ever reached our beaches.

The fear is that, if we cannot contain such disasters, what assurance do we have that nature will? Hurricanes spawn, grow, and blow themselves out. Floods subside, earthquakes redistribute geologic forces, and fires consume themselves. But with oil spills there is no similar point at which we can say, "It is over; we have survived." They are new disruptions, with no history or life-cycle we can count on, with no race-memoried assurance of whether, when, and how they might settle themselves out. Such man-made disasters have no life, and therefore no death of their own, no beginning in nature, and so no end. They are deadly passive, borne along by the very natural processes they contaminate, infiltrating the structures of life. And so, although the *Argo Merchant* has slipped beneath the waters and out of our headlines, its effects and those of the progeny it spawned bode to spread out endlessly, composing sad, tedious tales of lethality. □

Beginning a Year-Long
Series on How
To Make New Things Happen

Myron J. Exelbert,
Consulting Editor

Innovaha!tion

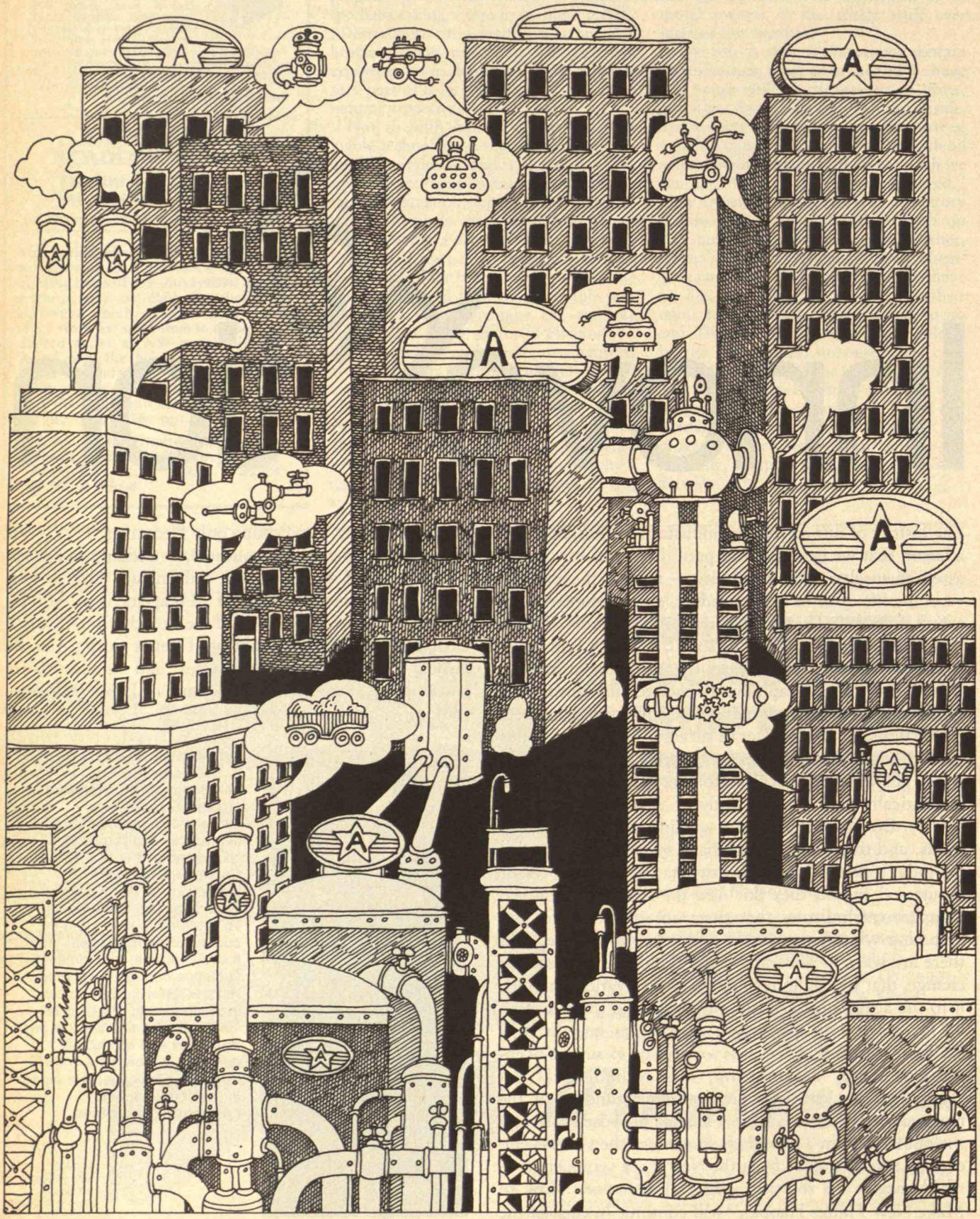
The history of our continuing industrial revolution offers a lesson that we ignore at our peril. Pressures for change assert themselves with regularity — indeed, inevitability — in the life cycle of every product, every company, and every industry. These pressures — sometimes subtle, sometimes dramatic — can be social, political, economic, or technological. In every case it is a process of innovation, the successful adaptation to change, that permits the product, organization, or industry to survive and prosper.

The ultimate determinant of survival and success in our market-oriented economy is profitability. But profit today is no guarantee of survival tomorrow, a lesson made dramatically clear in any study of American corporate history. Do the decline of the whaling industry, the railroads, and the vaccuum tube have messages and lessons for today's petroleum, air transport, and microprocessor industries? Indeed they do. And the study of industrial management indicates that there are guidelines for anticipating what is inevitable and what is feasible, that there are ways to understand and direct the processes of change, that we can in fact stimulate innovation and turn it to the achievement of our corporate and social goals.

Our purpose in planning a symposium held in New York in December, 1976, was to focus on examples of entrepreneurship, organization, and technological development that can enhance our understanding of the management of innovation. A similar purpose motivates the publication in *Technology Review* of the series — including several papers from the New York symposium — which begins on the next page. "Innovation: How to Make New Things Happen" will continue in each of the remaining issues — excepting only December, 1977 — of Volume 80 of the *Review;* authors, in addition to Professor Roberts on the next page, will include Eric A. von Hippel, Assistant Professor of Management at M.I.T.; Robert N. Noyce, Chairman of the Board of Intel Corp.; George R. White, Vice President of Xerox Corp.; Alan R. Fusfeld of Pugh-Roberts Associates; and Sumner Myers and Eldon R. Sweezy of the Institute of Public Administration. — *Myron A. Exelbert*

In the statement above, Myron A. Exelbert suggests the philosophy which motivated his organization of a highly successful symposium on "The Management of Innovation," sponsored by the M.I.T. Alumni Center of New York in December, 1976 (photo at left). Soon after that event he volunteered to help bring the outstanding contributions from that symposium to a larger audience through *Technology Review.* Mr. Exelbert studied management at M.I.T. (S.M. 1963), and he founded his own insurance and consulting business in New York in 1970 following a management career in the petroleum and broadcasting industries.

Innovaha!tion



Illustrations: Cameron Gerlach

Generating Effective Corporate Innovation

There is no rule book. But here are some principles of staffing, structuring, and strategy setting which can be ignored only at the peril of any company intent on assuring its future through technological innovation.

Edward B. Roberts
David Sarnoff Professor of Management
M.I.T.

Effective corporate innovation requires the planned integration of staffing, structure, and strategy. This view arises from 15 years of research at M.I.T. and elsewhere on the problems of managing industrial research and development and the technological innovation process. The results of our studies focus on four different areas which relate both to conventional research and development programs carried out by most technology-based firms and to the more venture-oriented new-product developments being undertaken by increasing numbers of such firms. There are both similarities and differences in emphasis between these two very different areas of technical innovation, and I'll try to point out these differences and their implications.

The four critical areas are these:

☐ The *staffing* of technical organizations must provide for the several key functions necessary to achieve successful innovation.

☐ The organization must be *structured* to enhance the flow of technical and market information into research and development.

☐ The organization's structure must also assure strong links with *marketing*, to assure that innovations effectively move forward into commercial success.

☐ The company must adopt *strategic planning* methods that improve integration of top management's technical plans with other dimensions of overall corporate strategy.

Five different key staff roles must be fulfilled if innovative ideas are to be generated, developed, enhanced, commercialized, and moved forward in the organization:

☐ The *creative scientist or engineer*, the source of creativity within the organization about whom so much — perhaps too much — has been written.

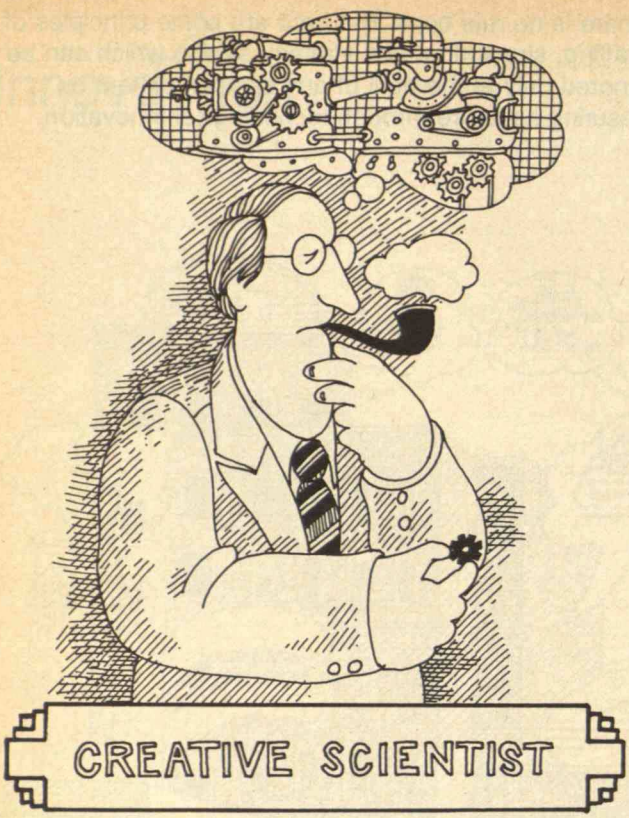
☐ The *entrepreneur* who pushes the technical idea (it may be his or someone else's) forward in the organization toward the point of commercialization.

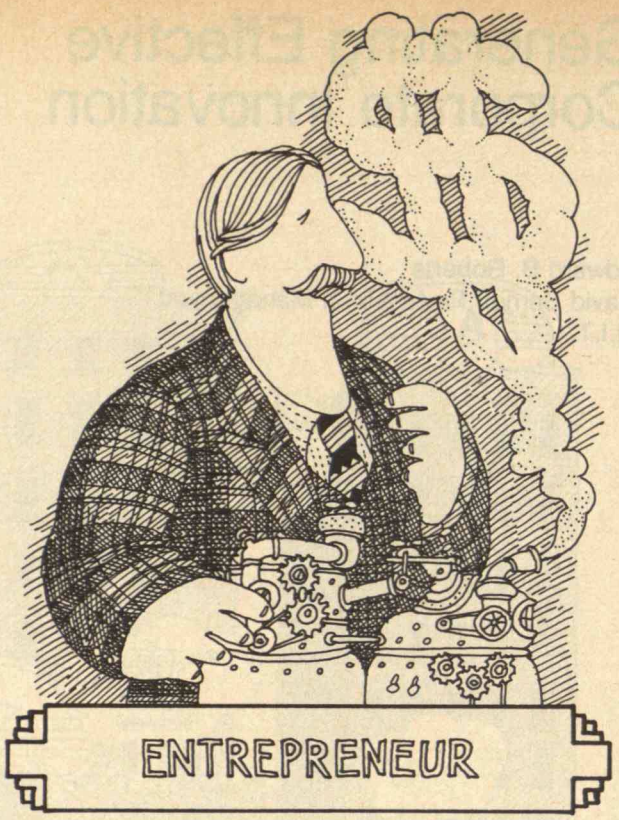
☐ The *project manager*, who can focus upon the specifics of the new development and indicate which aspects will go forward, which can be economically supported, and which must be deferred and who can coordinate the needed efforts.

☐ The *sponsor*, the in-house senior individual who provides coaching, back-up, and large skirts behind which entrepreneurs and creative scientists can hide. His role is that of protector and advocate — and sometimes bootlegger of funds — so that innovative technical ideas survive past the birth stage to gain the confidence of the technical organization.

☐ The *gate-keeper*, who brings essential information into the technical organization. Gate-keepers come in two varieties: the technical gate-keeper and the market gate-keeper; both of them account disproportionately for the information that is used in developing innovative ideas and moving the resulting processes and products forward into manufacturing and the marketplace.

In studies of many research and development organizations over the last 15 years, we have observed deficiencies primarily in all but one of these key roles needed for organizational effectiveness. The role of creative scientist seems to be over-emphasized; organizations tend to assume that having creative people on the payroll guarantees effective development of new products, new proc-





esses, and product improvements. This assumption is far from correct, and it has tended to cause systematic neglect of the other functions necessary for effective innovation.

This observation is important in the light of our conclusion that each of the several roles required for effective technical innovation presents unique challenges and must be filled with very different types of people, each type to be recruited, managed, and supported differently, offered different sets of incentives, and supervised with different types of measures and controls. Most technical organizations seem not to have grasped this concept, with the result that all technical people tend to be recruited, hired, supervised, monitored, evaluated, and encouraged as if their principal roles were those of creative scientists. But only a few of these people in fact have the personal and technical qualifications for scientific inventiveness; a creative scientist or engineer is a special bird who needs to be singled out and cultivated and managed in a special way. He is probably a strong, innovative, technically well-educated individual who enjoys working on advanced problems, often as a "loner." In an industrial laboratory, he is likely to be among the minority of scientists and engineers with doctorates, but education itself is by no means the criterion for creativity.

The entrepreneur is a special person, too — creative in his own way, but his is an aggressive form of creativity appropriate for selling an idea or a product. The entrepreneur's drives may be less rational, more emotional than those of the creative scientist; he is committed to achieve, and less concerned about how to do so. He is as likely to pick up and successfully champion someone else's original idea as to push something of his own creation. Such an entrepreneur may well have a broad range of interests and activities; and he must be recruited, hired, managed, and stimulated very differently from the way a creative scientist is treated in the organization.

The project manager is a still different kind of person — an organized individual, sensitive to the needs of the several different people he's trying to coordinate, and an effective planner; the latter is especially important if long lead time, expensive materials, and major support are involved in developing the ideas that he's moving forward in the organization.

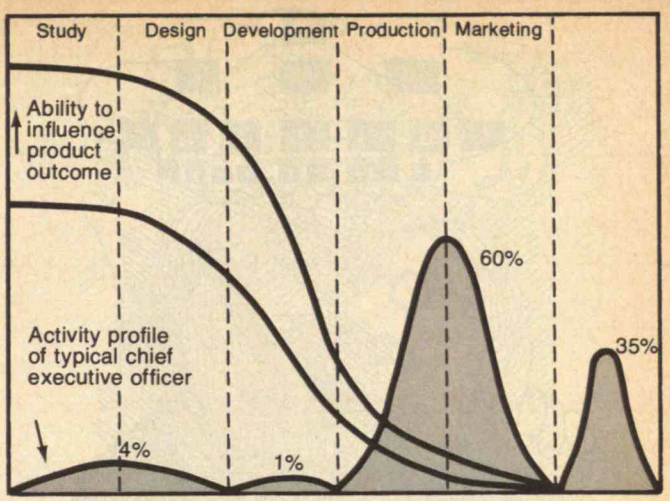
The sponsor may in fact be a more experienced, older project manager or former entrepreneur who now has matured to have a softer touch than when he was first in the organization; as a senior person he can coach and help subordinates in the organization and speak on their behalf to top management, allowing things to move forward in an effective, organized fashion. Many organizations totally ignore the sponsor role, yet our studies of industrial research and development suggest that many projects would not have been successful were it not for the subtle and often unrecognized assistance of such senior people acting in the role of sponsors. Indeed, organizations are most successful when chief engineers or laboratory directors take on this sponsor role as part of their natural behavior.

Finally, there is the information gate-keeper, the communicative individual who, in fact, is the exception to the truism that engineers do not read — especially that they do not read technical journals. If you're looking for a flow of technical information in a research and development organization to enhance new product development or process improvement, you have to look to these gatekeepers.

But those who do research and development need market information as well as technical information. What do

customers seem to want? What are competitors providing? How might regulatory shifts impact the firm's present or contemplated products or processes? For answers to questions such as these research and development people need people I call the "market gate-keepers," engineers or scientists, or possibly marketing people with technical background who focus on market-related information and communicate effectively to their technical colleagues. Such a person reads trade journals, talks to vendors, goes to trade shows, and is sensitive to competitive information. Without him, many research and development projects and laboratories become misdirected with respect to market trends and needs.

The significant point here is that the staffing needed to cause effective innovation in a technical organization is far broader than the typical research and development director has usually assumed; our studies indicate that many ineffective technical organizations have failed to be innovative solely because one or more of these five quite different critical functions has been absent. *(For the most recent application of our measurement techniques to research and development staffing issues, readers may wish to see Richard G. Rhoades' unpublished master's thesis on "A Comparison of Laboratory Performance by Means of Critical Functions Analysis," Sloan School of Management, June, 1977.)*



The expertise of a chief executive can most influence any new technology-based product development program in the program's early stages — during preliminary study, design, and development. But current research suggests to the author that chief executive officers actually devote only trivial amounts of their time and attention to these early stages of such new-product programs. Instead, they typically have significant involvement only during production and marketing — when "it's too late to do anything that can influence the outcome," says Professor Roberts. (This illustrative figure comes from related work by Foster and Gluck of McKinsey and Co.)

The Social Aspects of Technology

The structure of an organization also affects the success of its creative efforts. The need, of course, is for an interrelationship which enhances the flow of the right kind of information into and through the technical organization, assures its appropriate use there, and encourages the flow of results of technical programs from the research and development group to the other parts of the organization where they can be made to count.

No research and development organization produces a profit. At best such organizations can produce the technical bases that will permit the firm's marketing and manufacturing activities to produce the profit. Thus the search for effective, profitable innovation must embrace the interface relationships that bring information into research and development and move its results forward to other parts of the firm.

My colleague Professor Thomas J. Allen is responsible for some of the best studies in the country on the factors that affect technical information flow in an organization. *(See "Communications in the Research and Development Laboratory," by Thomas J. Allen,* Technology Review, *October/November, 1967; and "Design for Communication in the Research and Development Laboratory," by Thomas J. Allen and Alan R. Fusfeld,* Technology Review, *May, 1976.)* He has found, for example, that if you separate two technical people by 60 or 70 feet, you've suppressed the likelihood of technical communication by two-thirds; separate them by another 70 feet and you've essentially eliminated 90 per cent of the possibility of technical communication between them; furthermore, he finds no difference in the impediment to communication between 3,000 miles and 3,000 feet.

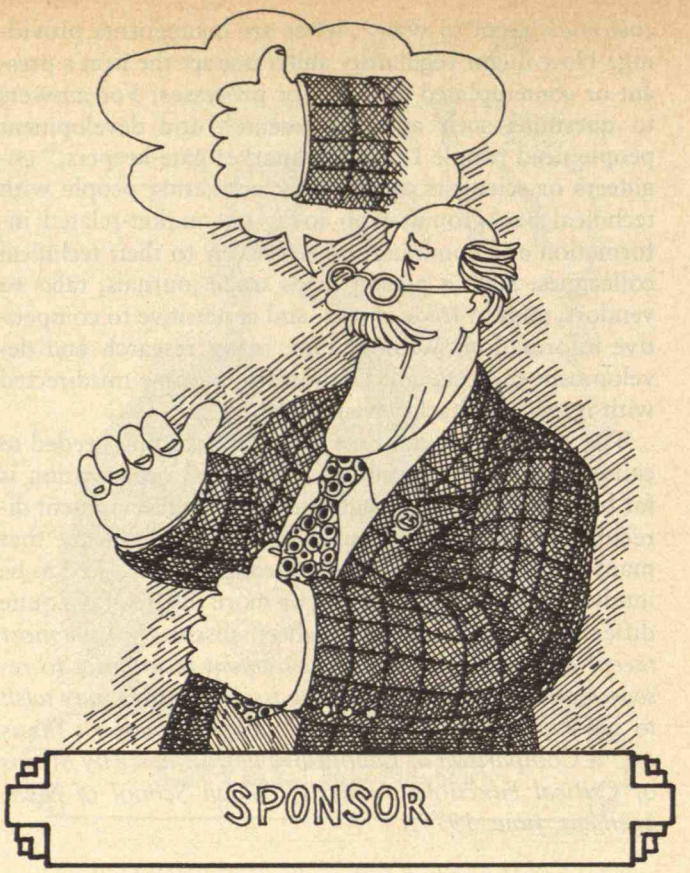
He has also found that the social relationships between technical people are critically related to the technical relationships between the same people. The person with whom you go to lunch or dinner is also the person with whom you'll talk about new technical ideas; the sources of technical problem-solving ideas within the firm correlate strongly with the sources of information about the Sunday afternoon football game.

Professor Allen's approach emphasizes the social aspects of managing a technical organization, an area that technical managers have seldom considered. If technology is to be useful in product improvement, new products, and new business, we must take a broader, more cultural view of what in fact takes place in the creation and enhancement of technical information flows.

Another view of information flow related to innovation results from the work of Professor Eric von Hippel of M.I.T., who has described and analyzed a series of possible patterns for innovations. He concludes that user-dominated innovation — that is, innovation inspired and often created by a customer rather than a supplier — is far more prevalent than we have assumed; and he proposes that both technical and marketing organizations should adjust their strategies to capitalize on the user domination of much innovation. *(See "Users as Innovators," by Eric A. von Hippel, forthcoming in* Technology Review *for January, 1978.)*

Choosing Among a Spectrum of Venture Strategies

Thus far I have emphasized issues related to information flow in innovation — where the ideas really come from and how they reach that critical point within the firm in which they will be thoughtfully considered. Now we come to a still more crucial issue: if the information comes into the firm and if the firm has the technical



know-how and other resources for using that information, then what has to be done to cause those innovative technical products to be developed and to move forward into the marketplace? Organization structures to link research and development outputs to the market vary greatly, and I shall limit my discussion here to the so-called "venture strategies."

Firms have moved in many very different directions in their efforts to respond to venture opportunities — new products and new business areas — presented by technological innovation. The spectrum of the firm's possible involvements is wide, ranging from the low commitment of undertaking venture capital activities to invest in someone else's development of a new business idea all the way to the other extreme of intensive internal venture management typical of companies like 3M.

For any given opportunity, each firm must select from within this spectrum the appropriate approach, depending on the available staff, the firm's general strategy, the resources available to move products forward into the market, and the characteristics of the markets into which the new products are to be moved.

To make clear the nature of these alternatives and the process of choosing among them, let me trace one company's experiences over the past 15 years trying to develop broad new business bases.

This multi-billion-dollar corporation began its venture strategy organization in 1960. For the first four years it followed a venture capital approach of investing in the start-up phases of high-technology firms — a policy the management called "window on technology," designed to provide varied perspectives on the sources of new technology and on new market opportunities. After four years in which the firm invested in 11 companies, the management concluded that "window on technology" was not providing adequate information and insights on the launching of broad, ambitious new businesses. So the venture capital approach was replaced by an internal venture research and development organization — a special laboratory group to develop new technical ideas. The firm's principal business was in the field of materials, and the new group's goal was to develop new product systems heavily dependent on special materials properties and know-how which would be forward-integrated in the market relative to the company's other businesses. Over a five-year period the firm spent $40 million of corporate funds in this activity; the result was two new products, both of which failed.

So at the end of five years management concluded that it was time to close out on this internal venture research and development approach. But the firm was still committed to creating new products and new businesses, and so management conceived of an opportunities analysis group to study broad ranges of market opportunities and pinpoint global business areas into which the firm should move. During the next two years, this opportunities analysis group presented eight major new business proposals to the executive committee of the company, and they scored a perfect record: the executive committee rejected every one. At the end of that period, the company was ready to scrap this approach for getting into new businesses.

But management remained committed to the need for venturing forth into new markets, so the company

adopted its present internal venture strategy of trying to develop small businesses based on off-the-shelf commercial exploitations to test on a pilot basis the company's ideas for different markets. And in fact, during the past several years this firm has been somewhat successful in entering a few new market areas.

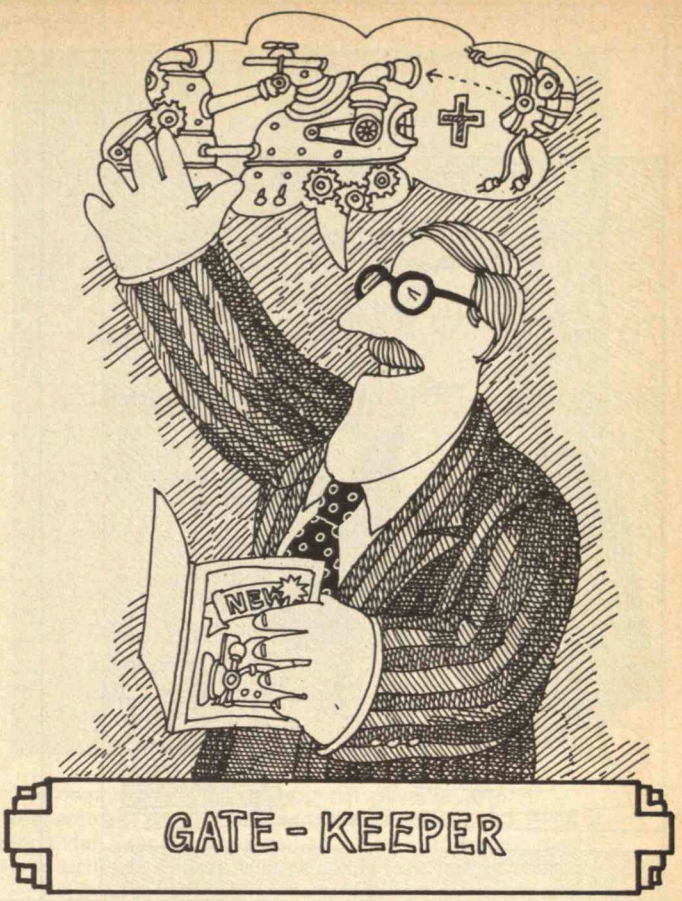
My point is not to emphasize this last apparent success, which may, in fact, soon turn into a failure. My point is rather to emphasize how much work and time are necessary to create a basis for meaningful diversification, and how many different approaches are available from which to choose.

Looking back at all of our studies of venturing, I think we have learned a few — not many — things:

☐ First, long-term persistence is required for any success in venturing into major new business endeavors. The 15-year failure record that I just described is somewhat on the long side but not really an uncommon experience. New-venture development of new products and new businesses is not something to go into for a year or two or three or four; it's something to which you had better have a long-term commitment supported by the belief that it matters that you succeed.

☐ Second, almost every successful new venture strategy is somehow dependent upon either copying or coupling to the strengths of small-company technical entrepreneurship. This is true whether you're engaged in venture-capital investments in new, high-technology companies, or in joint ventures trying to combine the technical ideas of a small new firm with the capital base and distribution capability of a large firm, or trying to create an environment in your own large firm that mimics in important dimensions the creative, aggressive, entrepreneurial milieu of the small, high-technology-based enterprise. All these strategies emphasize the virtues of the small, high-technology firm; it's intriguing to me that large corporations trying to enter innovative new businesses are simply doing their best to imitate what the small companies have been doing for many years. This suggests to me that large companies wanting to venture into new products and new business areas — and even those seeking merely to improve existing products and processes — might deliberately and very specifically look at new enterprise formation and growth and at the entrepreneurs who achieve it. Our studies demonstrate that the kinds of people who leave large, high-technology firms to form successful new companies are the same kinds of people who, when they stay in the large firm, are the key entrepreneurs behind new venture development there. In other words, there seems to be a particular kind of person who is going to try to do his entrepreneurial thing — whether on his own hook with a few hundred thousand dollars from a New York venture capital firm or inside the bowels of a major corporation investing several million dollars in attempts to launch new businesses.

☐ Third, no generalizations are possible on the subject of which strategy for new-venture development really works. When we look at the few major corporations who have successfully moved boldly into new businesses through innovative technology, we find that each one's strategies for success are very different from the others'.



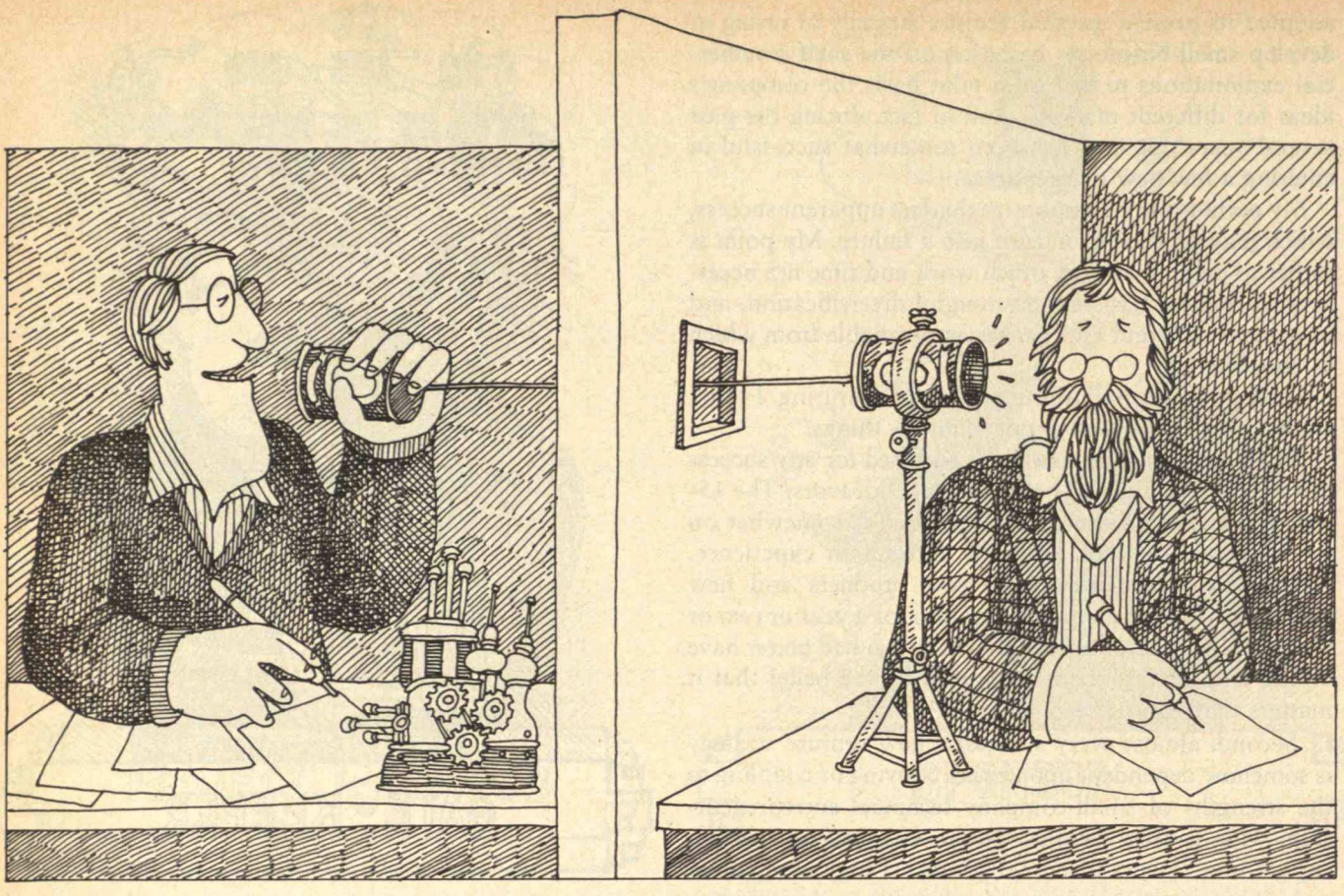
For examples, Minnesota Mining and Manufacturing Co. has for 30 years followed a strategy of depending upon internal venture stimulation with a beautiful organizational approach for creating and exploiting new ideas. In recent years Dow Chemical Co. has taken a very different approach, utilizing venture capital investment and outside technology acquisition as a strategy for building profitable new businesses. Through the medium of Exxon Enterprises — a still different strategy which appears to have strong merit and high possibility of success —Exxon is piecing together venture capital, joint ventures, and in-house research and development results into the base for significant new business entities.

These strategies are examples of success to be looked at carefully, but no individual or company can expect to be successful merely by mimicking any one of these strategies. The approach that works for one firm may not work for another, even if both firms do the right kinds of things about staffing and structure, because there remains the need to develop a formal technical strategy within the firm.

How to Win Profits by Planning Technology

Our studies reveal that most corporations have ignored technological strategy as an element of overall corporate strategy. For some reason, most firms limit their attention to financial and marketing strategies and planning, ignoring technology as a major area for assessment, planning, and strategic development.

Two authors forthcoming in this series will focus on this issue in much greater depth — George R. White, Vice President of Xerox Corp., who will give evidence that at



least one company does not ignore the technological component of strategy, and my colleague Alan R. Fusfeld of Pugh-Roberts Associates who will describe in much greater detail how technology planning considerations relate to strategy. But let me anticipate these discussions with the following comments.

No firm can divorce product from the technology embodied in that product. When we talk about the competitive positions of product lines two to five years hence, we are almost of necessity talking about the underlying technological basis of these product lines. An executive who wants to look at his firm's direction in the next half decade must start by profiling the competitive product positions of his company and studying the product and technology strategy options available to him.

What dimensions and approaches are relevant to monitoring technical performance? Which key projects need to be monitored by top management, and in what ways? For every product subcategory of the firm, where does the firm stand? Is the product's leadership clear? Are you in a product/technology parity position, or are you in a catch-up position with respect to your competition? Where were you with respect to those measures three to five years ago? Where will you be three to five years hence?

As you try to answer these questions for each major product or sub-product, you may be surprised and dismayed at what is revealed about the technological strengths and weaknesses built into your technical posture. You ought to have a deliberate strategy for technological development in each product category, and you especially need strategies for those products where you find yourself somewhat frightened as you analyze your future position.

Research and development should not be done on good faith. You should do research and development for strategically justified reasons, according to a clear strategy that says what you are trying to achieve and that gives you some measuring points at which you will be forced to evaluate and further justify what is being done. Can you find a way to take the offensive, launching forward with new technology in a bold way? Or are you going to be adaptive and exploitative, countering whatever the competition does and trying to make the best of a weak technical position?

What about related product areas — not the ones you're presently in but those that are close to these familiar areas? Is your present posture well defined? Do you have a strategy for the future? Are you going to be aggressive? If your chief competitior branches into a related area where he hasn't previously been, how will you respond? What about new products and new technologies? Do you have a technical program that will support your posture and strategy? Do you have research and development resources that match these intentions?

What about major manufacturing processes? Do you change them because manufacturing people tell you they have problems, or do you have a strategy? Do you want to change your firm's present manufacturing process, or do you want merely to respond to whatever the competition does by keeping even on the cost per unit item?

How do senior technical and general corporate managers invest their time with respect to the major new products and new innovative activities of the firm? Do you, in fact,

Is This Conversation Necessary?

Conventional wisdom holds that research and development workers' performance improves with personal contact with professional colleagues.

Not necessarily so.

True, the effectiveness of scientists working in basic research correlates directly with the extent of their communication with colleagues working in the same field in other institutions and companies.

But for engineers developing industrial technology in the typical research and development laboratory, similarly extensive communication with outside colleagues has a negative effect on performance. In this case what's needed is that unusual research worker who is also a "born communicator" — the gregarious "gate-keeper" who not only can reach out to workers in the same field in other organizations but can interpret their work in the context of his own organization's assignments and needs, says Thomas J. Allen of the Sloan School of Management at M.I.T.

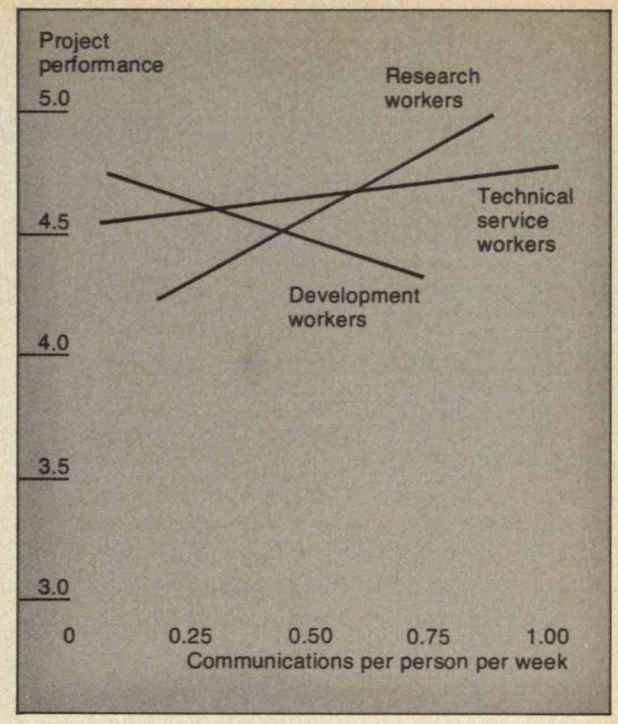
On the other hand, inter-company communication hardly figures for engineers in technical service work.

Professor Allen and his colleagues explain these different communication needs and strategies this way:

— Issues in basic science are defined in universal terms; everybody speaks roughly the same language and has the same goals. So almost everyone can communicate effectively with almost everyone else.

— Technological problems are usually defined in relation to corporate needs; the gate-keeper's ability to put others' work in the context of his own organization's assignments is crucial to his success as a communicator.

— Technical service problems are usually so well defined and closely coupled to organizational goals that outside inputs are unnecessary — and may even represent useless diversions. — *J.M.* □



The need for communication is not universal among research and development workers, says Thomas J. Allen of the Sloan School of Management at M.I.T. Those engaged in research — in contrast to development and technical service — will benefit from extensive professional communication with colleagues in similar work elsewhere. The average engineer engaged in development gains nothing from such communication. And communication with colleagues outside the organization has almost no effect on the performance of engineers in technical service projects.

involve the time of top management at the points of leverage that can affect the future of the firm?

At the very beginning of a new technology-based product development activity, a senior manager is able to influence the direction of the project in almost any way he chooses; he can stop it, enlarge it, accelerate it, redirect it, make it go for one piece of the market or another. The top manager's opportunity to be the bold innovator or the aggressive obsoleter of technology is greatest at that earliest stage. As the product moves forward into development, production, and finally marketing, the ability of the executive to influence the outcome goes down — eventually very close to zero.

But if you look at how managers typically spend their time, you find a very different pattern. Studies of this subject seem to indicate that chief executive officers spend trivial amounts of their time on the study and design stages of major new projects, the redirection projects of the firm. Instead the typical chief executive is primarily involved during the production and marketing stages of a project, when it's too late to do anything that can influence the outcome. The lesson from this is simple: if you want to affect the future of your firm, you need not only the right kind of staffing in your technical organizations and the right kinds of structures to enhance information flow in and transfer out. You need a strategic posture which displays critical points for paying attention to certain dimensions of product and technology, and you need to have an allocation of managerial time that brings the best talents of the company to bear on these focal points at the critical time.

For Additional Information

In addition to the related papers mentioned by the author and others which will follow in this series in *Technology Review,* Professor Roberts suggests readings in the following:

Allen, Thomas J., *Managing the Flow of Technology,* Cambridge: M.I.T. Press, 1977.

Fusfeld, Alan R., "Critical Functions: Key to Managing Teamwork in the Innovation Process," paper presented at Innovation Canada 1976 (copies available from the author at Pugh-Roberts Associates, Inc., 5 Lee St., Cambridge, Mass., 02142).

Roberts, Edward B., "Entrepreneurship and Technology," *Research Management,* Vol. 11, No. 4 (July, 1968), pp. 249-266.

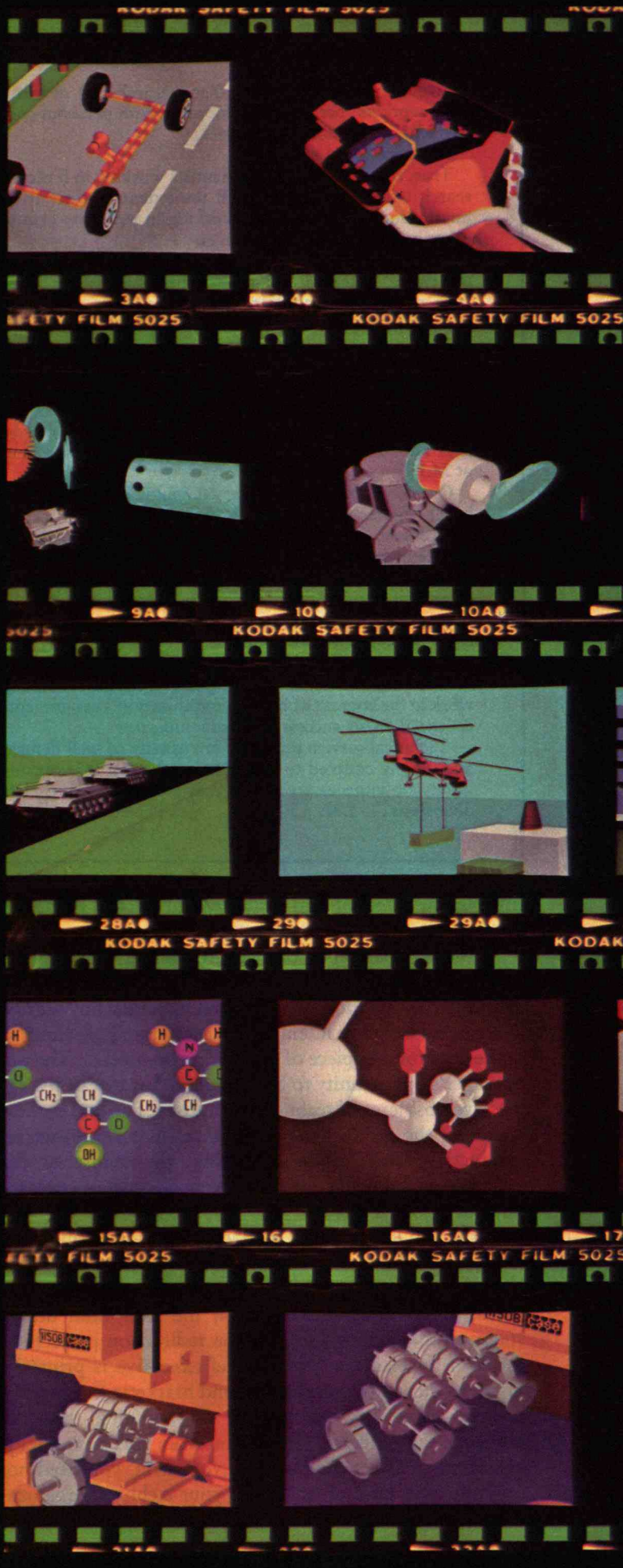
Roberts, Edward B., and Alan L. Frohman, "Internal Entrepreneurship: Strategy for Growth," *Business Quarterly,* Spring, 1972, pp. 71-78.

Edward B. Roberts holds four degrees from M.I.T. — in electrical engineering (S.B. and S.M. 1958), management (S.M. 1960), and economics (Ph.D. 1962); and he has been a member of the Sloan School faculty specializing in system dynamics, entrepreneurship, the management of research and development, and more recently health care management, for more than 15 years. Professor Roberts is co-founder and president of Pugh-Roberts Associates, Inc., management consultants, and he has worked for the success of several technology-based new enterprises as a member of their boards of directors. This article is based on Professor Roberts' remarks to a symposium on "The Management of Innovation" sponsored by the M.I.T Alumni Center of New York in December, 1976.

Computer Animation: Snow White's Dream Machine

Kenneth Kahn
Henry Lieberman
Artificial Intelligence Laboratory
M.I.T.

Computer animation can convey worlds that exist only in the imagination. One of its novel uses is in the simulation of large-scale and abstract processes. City planners can travel down the streets of a community of the future; designers can show the flight of an aircraft not yet built, or look inside a new transmission and watch it work. The ability to describe three-dimensions and complex motions by a computer has enlarged the ken of conventional animation.



Computers are often thought of as fast electronic calculators. And so they are, but they are also adept at making and manipulating complex images. A computer-controlled TV monitor can display realistic, almost photographic images, simple line drawings, or abstract "paintings" with dazzling patterns and textures. When thousands of these different images are displayed at a fast enough rate, the result is "computer animation."

Animation without a computer has been made for over 70 years. The basic process is very tedious, since as many as 24 pictures need to be drawn to produce just one second of animation. Thousands of hand-painted drawings are necessary to make a six-minute Bugs Bunny cartoon. Part of the history of animation techniques consists of the discovery of methods to reduce the amount of work. Animators use cycles of drawings several times in the same film. They typically paint sheets of clear acetate, called "cels," so that only that part of the image that changes need be redrawn — the background and more static elements are on separate cels and can be seen through the clear acetate. While these labor-saving techniques are often used with little loss in quality, their overuse has resulted in the limited animation seen on Saturday morning televison.

Computer animation can alleviate the tedious labor involved in making animated films. Computer systems capable of producing high-quality images are only now becoming cheap and fast enough to do this. An animator can "paint" a set of pictures directly into the computer's memory. Then the computer can smooth the transition between images in that sequence by creating a series of

(Photo: Mathematical Applications Group, Inc.)

in-between drawings. Such systems will enable animators to produce many quality cartoons in the time it now takes to make one cartoon by hand.

But most of the computer animation that has been made was not with the aim to save work or money but because they could not have been produced by hand. The computation to produce a film of a sphere being turned inside-out (*see p. 42*) or a stress-colored supersonic transport in flight is too great to be done without a computer. Another advantage that computer animation has over conventional animation is its modifiability. Once a program is written to produce a film, it is easy to make variations. After the film is made, it can be seen, evaluated, and remade with little effort. Without the computer an animator would be forced to redraw thousands of drawings to modify the colors or appearance of a character or object in the film.

Who's Doing It

Animation has gained new scope with the introduction of the computer. Many of the films are educational and depict objects or processes that are difficult to observe or envision. Physics films portray flights at relativistic speeds (Judah Schwartz and Edwin Taylor at M.I.T.), crystals growing (Ken Knowlton at Bell Labs), and the effect of different laws of gravitation on planetary orbits. Nelson Max, a mathematician at Case Western Reserve, showed a sphere being turned inside out and curves filling space. Ron Baecker, a professor of computer science at the University of Toronto, makes computer films to help students visualize the steps of a program as it is executed or the operation of a sorting algorithm.

Scientists and engineers are able to visualize data that would otherwise be difficult to interpret. "Solar Corona," made by Michael Beeler at M.I.T. in 1972, uses various colors to represent different surface temperatures on the sun. Color has been used in other films to depict the levels of stress both on bridges as trucks drive over them and on supersonic transports flying under different conditions.

A niche has been found for computer animation in the commercial world. It can simulate new products for industry or space exploration for government. They can be observed before large sums of money are invested. Mathematical Applications Group, Inc. has made a film, for example, which shows an internal combustion engine where the "camera" is inside a simulated engine and can "see" through metal to pistons and other moving parts. Another is one which shows the flight of a multi-lift helicopter which exists only on the drawing board at Boeing. Or one can view the architectural design of a community of the future from the air or as it would look to drive along its streets (*see p. 35*).

Computer systems capable of producing animation are typically acquired to make instructional films or to develop better systems. People soon discover that these systems are also very well suited to producing *artistic* films. Collaborations of artists and computer scientists — John Whitney, Ken Knowlton, Lillian Schwartz, and Stan Vanderbeek — have produced award-winning films of beautiful geometric forms and patterns that change in complex rhythms. They used computer graphics systems that were designed for scientific and engineering applications. The lack of systems especially adapted for artistic or entertainment purposes is due mostly to the high price of computers and displays. But as the costs of computers continue to fall we will begin to see the use of computer graphics systems in animation and graphics studios.

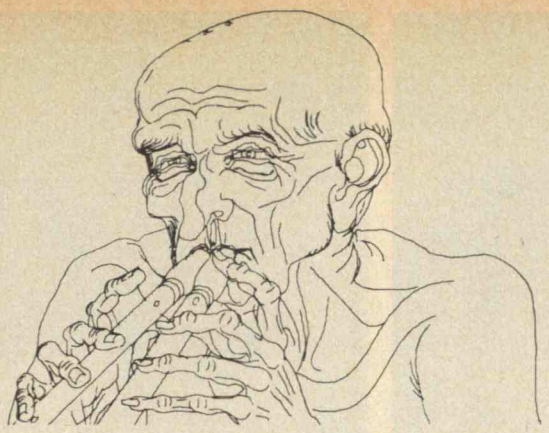
An intriguing use of computer animation is as an environment for learning about computers and programming. The Logo Group of M.I.T.'s Artificial Intelligence Laboratory, the Learning Research Group at the Xerox Palo Alto Research Center, and Logo groups in Great Britain, France, Germany and Canada have recognized the potential in computer graphics and animation for a student to learn to use computers in a manner that is highly responsive, intuitive, and visual. Children quickly learn to make simple programs that draw complex images. They are able to watch their programs in action as they draw pictures and animated shapes. As they advance, they program animated movements and achieve better control over the images. Students become much more excited and involved when they produce visually impressive animation than when the computer is used in a more conventional manner, for example, to print a table of prime numbers.

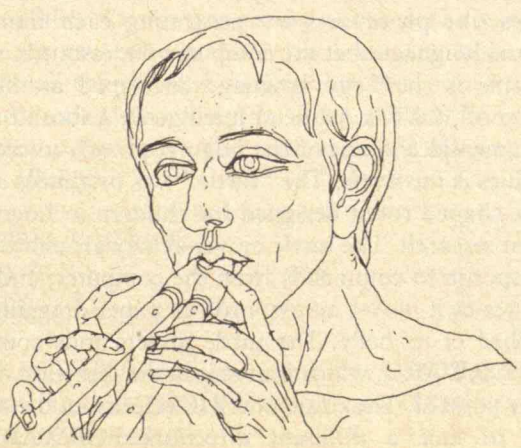
"Painting" Onto the Screen

There are several different ways a computer can be instructed to manipulate its memory to create a desired image. Most of these methods can be classified as either "demonstrative" or "procedural."

A demonstrative program allows the animator to indicate to the system exactly what a picture should look like by drawing it by hand instead of describing it in a stylized computer language. The first program which was able to do this was Ivan Sutherland's Sketchpad, a system he developed in the early 1960s as part of his doctoral research at M.I.T.'s Lincoln Labs. The user sketched a drawing with a light pen that the computer was able to sense. Once the series of pen movements were made, the computer could play them back at high speed as originally drawn or distorted mathematically. Ron Baecker about five years later, also at Lincoln Labs doing doctoral research, extended this idea in a system called Genesys. A series of pen movements could be interpreted either as a shape or as a path that the shape should follow. A frog could be drawn, a bouncy path sketched, and the computer could then display the frog jumping along that path. Since then other systems have developed into quite sophisticated environments for visual expression.

The National Research Council of Canada explored another technique for creating demonstrative computer animation called "key-frame" animation. The idea is to draw two slightly different pictures. The computer then re-creates the first drawing and creates a large number of intermediate drawings by slowly moving each line from its position in the first drawing to its position in the second. Using this technique an animator need only create a tenth as many drawings as he or she would otherwise draw. Peter Foldes, an Hungarian animator, while at the National Film Board of Canada used this system to create smooth transitions, and also others verging on the bizarre





Selected frames from a "key-frame" animation sequence in Peter Foldes' film, "Visage," are shown at left. Using this technique, the artist draws key images at selected intervals in an animation sequence and then the in-between images are computed by interpolation. This technique frees the conventional animator from the task of specifying minute transitions, and allows a range of experimentation with distortion and shape changes. (Photo: National Research Council of Canada)

by drawing vastly different images each time (*see left*).

A group of computer scientists and conventional animators at the New York Institute of Technology is currently trying to create a system that combines the best of Baecker's Genesys system and the key-frame systems. In addition, they are adding colors and textures to their system. Within their system it is possible to have the computer create the in-between drawings or to describe the motion of an object demonstratively. They also have developed a "paint brush" system where one can draw with imaginary brushes of any size, color or shape. One can even draw a desired brush and then use it!

The paint program is currently one of the most popular means of creating computer animation in the demonstrative style. Paint programs turn the computer into a super paint brush and canvas which can do anything an ordinary paint brush can do. But the computer gives the artist a flexibility unavailable to the user of permanent paints. Once a picture is drawn, the computer can provide operations for changing aspects of it, such as moving, rotating, enlarging or shrinking the picture or rearranging its colors (*see pp. 38-39*).

The "brush" that is used in paint programs is one of several types of devices which report their position on a drawing surface to the computer. The most popular are the *light pen,* a pen with a photocell which is pointed directly at the display screen; the *tablet,* a pen which is moved on a special drawing board; the *mouse,* which is rolled across a flat surface on two wheels; and the touch panel, which allows "finger painting" on the screen. The computer marks the current place on the screen with a small blinking picture called a cursor, which is moved around in response to the movements of the artist's hand.

The simplest way to use a paint program is to use the cursor as a "pencil" with a line being drawn wherever the cursor moves. Many paint programs provide a handy tool, called the "rubber band" line, for drawing perfectly straight lines. One point remains stationary on the screen, and as the cursor moves, a line is displayed between the fixed point and the cursor, as if an imaginary rubber band were being stretched between them. When the second point is placed exactly where it is desired, the line is made permanent. A perfect circle may be made by indicating where the center should be and another point to determine the circle's radius. Facilities for creating other types of curves or shapes may be provided as well. The com-

"Paint" systems give an animator a range of drawings beyond the conventional pen and brush. They provide special features which allow immediate transformations of color and size to be made with a simple indication to the computer. Colors and brush function are chosen from a "menu" which appears above and below the screen. The animator draws the desired image on a tablet, or in some systems directly onto the screen with a photocell-equipped pen. Different brush widths and straight lines are featured in the menu at the far right. Or a drawing can be made and "flooded" with a particular color (above center) and later modified by a different choice of color, or shrunk or enlarged to a specific shape and position (above right).

puter can be instructed to draw a special type of line, such as a dotted or dashed line instead of a solid line.

Paint programs are controlled by a *menu*. Each possible choice in the menu is represented by a word or picture, and all the choices available are displayed in a designated area of the display screen. A choice is made by moving the cursor to point to the desired option.

The menu usually displays several shapes which can replace the point of the pencil with a brush to draw thicker lines or swatches. The brush can be dipped in paint of any color, chosen from a spectrum of colors displayed in the menu. Various kinds of "magic" paint, which behave unlike any real paint, are possible. Paint can have textures and patterns such as stripes or polkadots, or a repeated design like wallpaper. Even the colors of the paint can change in time so that, for example, the paint can yellow with age. There can be a special kind of erasing paint, which removes any paint which it goes over. If the artist wants to experiment after a color is chosen, the hue of that color can be changed without affecting the other colors.

Areas can also be filled in, using a technique similar to a child's coloring book. A closed curve outlining the region can be drawn, and the computer can be requested to fill the area with paint of any of the colors or textures available. Pictures can be transformed and manipulated once they are drawn. The transparent cels used in animation by conventional techniques can be simulated — so the foreground can be changed in front of a constant landscape. A picture can be enlarged, shrunk, or stretched. A bird and a tree of the same size drawn separately can be combined to show a diminished bird nesting in that same tree. "Key frame" animation can facilitate the transition between two drawings of important frames. The availability of all these operations encourages artists to create in a much more interactive style. The artist can experiment freely with the different images, knowing that they can be edited if they are unsatisfactory.

The Shazam system, developed by Ron Baecker at Xerox, is an example of an animation system based on demonstrative style paint programs. In addition to the facilities described above for creating static pictures, this system includes special features for describing the motion and change of pictures in the course of a movie. To create a movie of a bouncing ball, the ball can be drawn using the painting tools, then the animator can describe the motion of the ball by sweeping the cursor along a curved path. The ball's appearance can change in the course of the movie by selecting a different picture. The motion sequences for several different characters in a movie can be defined independently, and the results combined in a single movie. As work on the movie proceeds, it can be played back continually, so that the animator can simultaneously watch the results and make modifications such as speeding up or slowing down the action.

Talking to a Turtle

An equally common way of producing computer films is to describe procedures for generating each frame in a stylized language that the computer understands. A good example is the Logo language developed at the Logo Group of M.I.T.'s Artificial Intelligence Laboratory. The fundamental concept of the Logo approach to computer graphics is the *turtle*. The "turtle" was originally a small, dome-shaped robot designed for children in Logo's education research. The turtle moves slowly around the floor in response to commands from the computer, and draws pictures as it moves across a roll of paper dragging a pen attached at its belly. The turtle understands commands like FORWARD, which moves it in the direction it is currently pointed. The command RIGHT causes the turtle to turn to face a different direction. FORWARD and

Any imaginable brush can be described and then used with "paint" programs. A heart-shaped image was drawn, reduced in size, and then used as the brush in the drawing at left above. This drawing was then used as a "wallpaper" to flood a defined area in the center figure. The system can also provide an airbrush function, in which the user decides the width, angle, and distance of a brush which sprays its colors upon the screen (far right). (Photos: Walter Lieberman and Kenneth Kahn; M.I.T. Architecture Machine)

RIGHT are given numbers that say how far to go. The turtle has a pen which can be either up or down. If the pen is down when the turtle moves, it draws a line between the old and new positions. Now, the idea of drawing pictures with turtle commands is used for creating pictures on displays. A "display turtle" is an imaginary creature who lives on the screen and understands the same commands as the robot turtle.

In Logo, the turtle can also be taught how to perform new commands. To get it to draw a square, for example, the turtle would have to go FORWARD four times, turning RIGHT 90 degrees between each line drawn. This is expressed in Logo by defining a procedure,

```
TO SQUARE
REPEAT 4 FORWARD 100 RIGHT 90
```

which would draw a square of 100 turtle steps on a side whenever SQUARE was typed. Many squares could be drawn at different places on the screen simply by moving the turtle to each starting point and typing SQUARE. The ability to write procedures to draw pictures gives the user new flexibility. Once a procedure is defined, the computer can use the new concept that it has learned in other situations. Small changes and additions to the procedure significantly extend the computer's capabilities. For example, a new command which uses the SQUARE procedure can be created.

```
TO TURN. SQUARE
RIGHT 10
SQUARE
```

TURN. SQUARE would turn the turtle by 10 degrees before drawing the square, so the square would be drawn in a different orientation.

Notice that the SQUARE procedure given above draws the same size of square each time it is used. Since the turtle has just been taught how to draw a square, it would be nice if this could be generalized to draw squares of any size. The SQUARE procedure could be made to take a number to tell it how big a square to make, just like FORWARD takes a number to tell it how long a line to draw. Let's refer to that number as the square's SIZE.

```
TO ANY. SIZE. SQUARE :SIZE
REPEAT 4 FORWARD :SIZE RIGHT 90
```

Then ANY.SIZE.SQUARE 200 makes a square with sides 200 steps long, and the turtle can now draw squares of any size. A variation of this program is to change the amount the turtle turns RIGHT as well as the amount it goes FORWARD, continually repeating the steps of going FORWARD, then RIGHT.

```
TO POLY :SIZE :ANGLE
REPEAT.FOREVER FORWARD :SIZE
                RIGHT :ANGLE
```

This procedure can draw all kinds of regular polygons and stars. If the amount the turtle goes forward is increased on each repetition, the turtle can then draw spirals. The strength of the procedural approach to animation is that one simple procedure like POLY can describe a wide range of interesting pictures.

Here is an example of a simple animated movie, in which a square rotates about one of its corners. The movie will consist of a succession of frames, repeated rapidly to create the appearance of smooth motion. Each frame should show the square, then between frames the screen should be erased and the square should be shown in the next frame turned slightly from the previous frame.

Computer Theater

Suppose we wanted to make the following simple film. Sally, Bob, and Tom are colorful flowers swaying in the wind. Sally, however, is not getting water and is slowly turning brown. Sue is a rocket who is flying by. She sees Sally's plight, drops a water balloon on her and Sally regains her original colors. We shall use an animation language called Director, that is now being developed by Kenneth Kahn at M.I.T.'s Artificial Intelligence Laboratory. The basic philosophy of this procedural language is to treat each object on the screen as actors which are given scripts. Each actor has its own appearance and can follow a script that consists of instructions to move, turn, grow, change color or shape. New kinds of instructions can easily be defined. After the actors have been created and given their scripts they are run together resulting in an animated movie.

First we will need to create the flowers — Sally, Bob and Tom — so we ask the actor called "Flower" to create them and then tell each of them their appearance and position. Previously, the system was told how to make a prototype flower in much the same manner as the turtle was told how to draw a square or polygon (*see page 39*). We can create the flowers by typing this to the computer:

```
ASK FLOWER (MAKE SALLY)
ASK SALLY (SHOW)
ASK SALLY (CHANGE YOUR NUMBER OF PETALS
          TO 7)
ASK FLOWER (MAKE BOB)
ASK BOB (MOVE TO LEFT 100 STEPS)
ASK BOB (CHANGE YOUR COLORS TO (RED ORANGE
        YELLOW))
ASK FLOWER (MAKE TOM)
ASK TOM (MOVE TO RIGHT 100 STEPS)
```

The actor Flower creates flowers and makes assumptions for the number of petals, color, position, unless told otherwise as in Tom's case.

The next problem is to get the flowers swaying back and forth. First we must "teach" the actor Flower how to sway. After we do this any flower will be able to follow instructions in a script to sway. We could type:

```
ASK FLOWER
    (RECEIVE (SWAY)
        (DO-THE-FOLLOWING:
        (TURN LEFT
        10 DEGREES
        AFTER 1 TICK)
        (TURN RIGHT 10 DEGREES
        AFTER 2 TICKS)
        (SWAY AFTER 2 TICKS)
```

Which means roughly in English, "If you are asked to sway, then turn left, then after the tick of an imaginary clock turn right, and at the next clock tick start all over again." We must tell the flowers to sway by typing:

```
ASK SALLY (SWAY)
ASK BOB (SWAY)
ASK TOM (SWAY)
```

Next we want Sally to turn brown, so we add to her script by telling her:

```
ASK SALLY (CHANGE YOUR COLORS TO (BROWN)
          IN 6 TICKS)
```

We now need to create the rocket Sue, describe her size, speed, initial position and how to shoot the balloon. To enter this script for Sue we type:

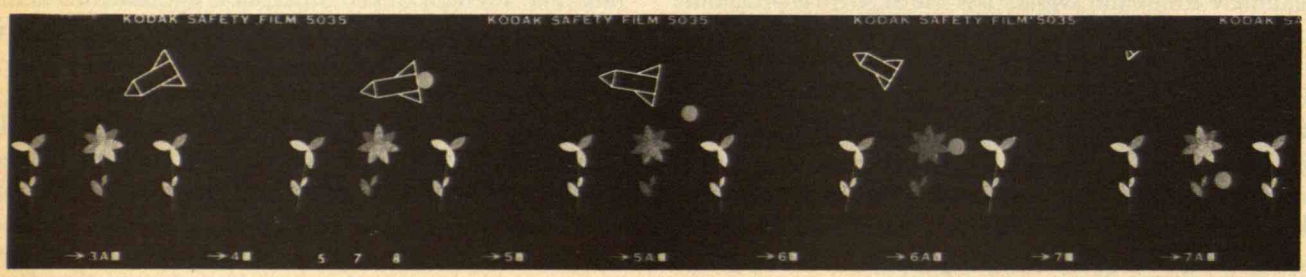
```
ASK SUE (GO FORWARD 300 STEPS)
ASK SUE (SHOOT BLUE BALL TO GO 200 STEPS
        AFTER 3 TICKS)
ASK SUE (TURN RIGHT 90 DEGREES AFTER 5 TICKS)
```

Finally we need to ask Sally to restore her colors to normal.

```
ASK SALLY (CHANGE YOUR COLORS TO
                  (RED ORANGE YELLOW)
                  IN 3 TICKS
                  AFTER 6 TICKS)
```

The result of this few hours of programming can be seen below. In addition to creating a program capable of producing this little movie, we can easily make changes and see the variation soon after. We can easily change the speed, size, position or colors of any of the objects and let the computer re-compute the movie. If we were making this movie by hand, we would have to re-draw almost all of the pictures. Next time we want to make a movie in which an object sways back and forth, or that shoots out an object, our task will be greatly eased by having defined those actions in making this movie. Or suppose we liked the film but thought that Sally changed her colors too quickly to brown and that brown was too dark a color, then we need only change that one part of Sally's script to have her, say, change her color to tan in ten ticks. — *K.K.*

Procedural languages are being designed which are simple enough for a user with relatively little knowledge of computers to make animated films. The selected frames below are from a film by Kenneth Kahn, the developer of Director, the computer language which treats each object as though it were an actor with a script to follow.



MIT '78

Articles

Departments

The Class of 1981: The Yield Is Up, Housing Tight, Everyone Pleased

As their orientation week ended, the Class of 1981 entering this fall was estimated to number 1,076. That's nearly 100 more than the enrollment which the Faculty Council proposed to the Admissions Office last spring — and thus it's a source of both comfort and concern in Cambridge.

Concern, because on-campus housing facilities, which would have been hard-pressed to house 1,000 freshmen, are tighter than ever before. To ease the crunch, Random Hall (used as a dormitory until 1971, when it became temporary housing) will once again be used as an undergraduate dormitory for 96 students. Will overcrowding really compromise the on-campus living environment which is conceived to be "conducive to personal development"?

Comfort, because more students accepted M.I.T.'s offer of admission than expected, more than last year by about 10 per cent. Last April, 1977, the Admissions Office sent acceptances to 1,933 secondary school seniors; if 1,115 actually come, that will be a "yield" of 58 per cent. In 1976 the "yield" was only 46 per cent.

Why such a big change in this critical figure?

Do We Choose Them or Do They Choose Us?

One possible cause of the increase, explains Peter H. Richardson, '48, Director of Admissions, was simply timing. Historically, M.I.T. replied to applicants in the last week of March; the major competition (where half of the students admitted by M.I.T. eventually choose to go) mail on April 15; students must reply by May 1.

M.I.T.'s "yield" went from 54 per cent two years ago (when our mailing was in the end of March) to 46 per cent last year (when the mailing was in mid-April) up to 58 per cent this year (when we again mailed at the end of March). "That extra two-three week time is terribly critical to us," says Mr. Richardson. The Educational Council members "did a terrific job this spring,"

Nineteen ways to say welcome from the International Student Association greeted nearly 1,100 freshmen arriving in Cambridge on September 2 to become the Class of 1981. (Photo: Calvin Campbell)

Resist "Selfish Opportunism": An Editor's Warning to the Class of 1981

When he went to write his editorial advice to new members of the Class of 1981, William Lasser, '78, Editor-in-Chief of The Tech, *dug into the morgue to find inspiration in* The Tech *of a decade ago. In an era of political activism, its editors were describing M.I.T. as a "politico-technological pressure cooker." But times are very different now, writes Mr. Lasser:*

M.I.T. is still a pressure cooker. One undoubtedly gets quite an education here. But political activity is practically nonexistent — the M.I.T. student body yawned its way through the Presidential election last fall, then turned around and elected an Undergraduate President and Vice President who promised "leaves on the trees," and, like Jimmy Carter, peace, love, and happiness.

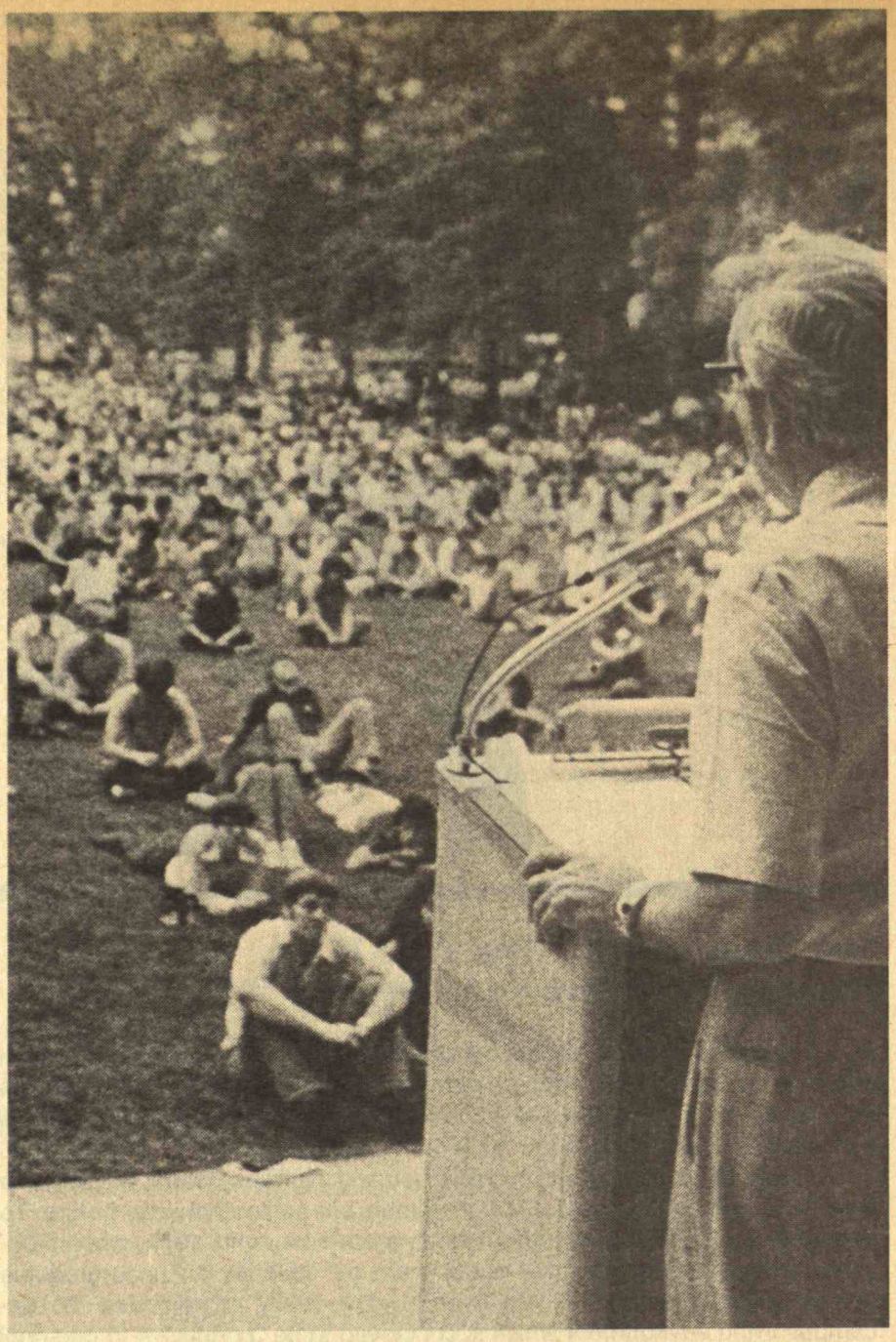
If M.I.T. students eschew politics, they are intimately concerned with economics, especially of the practical variety. From the beginning of freshman year through graduation and beyond, the overriding concerns seem to be jobs and money. Grades have become overwhelmingly important, at the expense of extracurricular activities and simple fun. M.I.T. has become not an end in itself but a means to future success — be that medical school, graduate school, money in the bank, or a two-martini lunch.

Because of ever-increasing tuition, shrinking job markets, and unceasing competition, today's college students have little time to devote to social issues. We have become used to listening not to Vietnam casualties but to "leading economic indicators" and the consumer price index on the evening news.

It is well documented that in times of economic crisis, men direct their energies towards self-survival. But an education does not consist of courses and grades alone. It is also important to use four years of college as an opportunity to explore the world around you while still being protected and insulated in an artificial academic environment.

Of the four years at M.I.T., the first one is the most important. A welcome indication of where M.I.T. stands philosophically is freshman pass/fail grading: the educational emphasis is less on specific course material and more on developing a modus operandi for enjoying and taking full advantage of M.I.T. and the real world. In practice, things don't always work out that way. Spurred on by pre-meds who insist that Harvard really *does* care about your 5.41 grade, freshmen ignore the wealth of opportunities waiting for them outside the classroom.

Twenty years from now, no one will ask whether you took 8.01 or 8.012. The biggest decision is one you will make long after R/O week: whether or not to take full advantage of *everything* the Institute offers. Life begins after classes.



President Jerome B. Wiesner's advice to the Class of 1981, as he welcomed them to M.I.T. at the picnic in Killian Court during the first hours of orientation on September 2: "Don't work too hard, or at least too singlemindedly." Concentrate especially on "developing and polishing your habits of mind," he said. When he asks alumni what they most value from their M.I.T. experience, they tell Dr. Wiesner that they can't remember what they studied — only that they learned "to work hard and think clearly."

Then Dr. Wiesner went on to introduce the new Class to itself: 1,076 students, 177 of them women; age between 16 and 25; from 29 foreign countries, 47 states and Puerto Rico; 242 from New York, 121 from Massachusetts, 66 from Pennsylvania; graduates of 737 public, 122 private, and 22 foreign schools — with 14 from the Bronx High School of Science. (Photo: Calvin Campbell)

says Joseph A. Edwards, '72, Director. "This year they had time to contact the students and did so with enthusiasm."

Yet there are many other contributing factors, and much speculation. This year, for instance, a group of 25 M.I.T. faculty members called students after they were admitted to congratulate them. It was well received — and statistics indicate that the faculty did influence students' choice.

Perhaps it is an overall trend: this year every college seems to have reached or exceeded expected enrollment; not many schools turned to their waiting lists, adds Mr. Richardson.

He is pleased that the "yield" is rising. It makes the selection process easier, he says: "If 100 per cent of the admitted students come, then we choose them; if 50 per cent come, they choose as much as we do."

The Admissions Office constantly seeks information about why students choose — or reject — M.I.T. This year, included in the students' reply card is a request for an explanation of his or her answer. This will not change the "yield," explains Mr. Richardson, but will facilitate a cancellation study so it may be done by September 1, instead of the usual time, October or November.

Increasing Competition for the Best Students

There are two M.I.T.s, muses Mr. Richardson: one is impossible to get into, has no women, no athletics, works students so hard that they have no time for anything, produces pale and shallow automatons. And if you get in, you'll flunk out right away, or shortly thereafter.

Then there is the real M.I.T.: offering a tremendous variety of athletics, a first rate symphony orchestra, outstanding curricula in political science, economics, linguistics, coed for 105 years, and "more going on in and about the campus than any institute I know of," he says. "M.I.T. has a flexible, diverse population — and it cares about its students. I've had kids who have attended one, two, three, and four other institutions, who love M.I.T."

His concern is to publicize this reality — and to dispel the lingering negative image of the other extreme. Times have changed: when students entered M.I.T. between 1940 and 1960, explains Mr. Richardson, the opportunities for first-rate education in the non-private sector were limited, physically and by reputation. But now, expanded facilities and quality education in the best state universities — at a tremendous saving in price — increase M.I.T.'s competition. And the total cohort of 18-year-olds is shrinking, reducing the numbers of applicants. So more places for fewer people puts M.I.T. in an increasingly difficult competitive position, he explains. Students are being courted; colleges are using increasingly sophisticated marketing techniques.

Our alumni are a valuable source of positive publicity for M.I.T., he emphasizes. They are encouraged to be more instrumental — to ask "have you considered going to M.I.T.?" more often.

The Class of '81

Who, then, is the Class of '81? It will take a while to tell, says Carola B. Eisenberg, Dean for Student Affairs, but there has been a noticeable change in the characteristics of recent incoming classes: they are harder-working than the classes of five years ago, more oriented toward specific goals, not as politically active. "Each year they seem more and more wonderful," says Dean Eisenberg; "they are a marvelous bunch of people."

A major effort in the Dean's Office is to ease transition from home to college. To provide M.I.T. with more personal information about each student (besides scores and grades and extracurricular activities), parents are asked to write a letter describing their sons or daughters. No one has access to this letter except the student's faculty advisor. It can prove a valuable source of information if the student is having difficulties. And it reveals a view of the parents as well, says Dean Eisenberg.

The Dean's Office informs parents, too: "We send a letter around Thanksgiving describing what has happened at M.I.T. in the fall, so that when parents see their children at Christmas, they don't have a blank expression; they have the beginning of a conversation. And they know some of what their children have been doing and a little more about what their investment in a college education may yield." — *M.L.*

Living in Random Hall

When the buildings were first turned into student housing in 1967, their *ad hoc* nature led funsters to call the establishment Random Hall, and the name has stuck.

Since 1970 the undistinguished yellow brick Boston-style apartment units facing Massachusetts Avenue four blocks north of M.I.T. have served as a lodging for visiting fellows, temporary staff, and occasionally students. Now, with over 1,075 freshmen registered, they've been returned to service as a unit of the residential system accommodating 100 men in 42 singles and 29 doubles.

Preliminary calculations by Kenneth C. Browning, '66, Associate Dean for Student Affairs, showed that 1,100 freshmen would result in overcrowding the dormitory system by about 130 students — in addition to the overcrowding accomplished last year, when 96 beds were added by converting doubles to triples and lounges into rooms. Random Hall, Institute property already licensed as a rooming house, was an obvious solution.

Minor renovations were completed during the summer. There is a common area on each floor of the interconnected buildings, and space was provided for a faculty resident — still to be chosen at press time — and three graduate tutors.

Can You Play the R/O Week Game?

Members of the Class of 1981 arrived at M.I.T. on Friday, September 2, fully ten days before Registration Day. What happens during that "Residence/ Orientation Week"? Here's the answer, on these and the next two pages — a sort of "game plan" as published in this year's *Freshman Handbook.*

Alumni readers will understand it all, we think, except perhaps one term: When you're in **limbo** (*see lower right, opposite page*) you're living in temporary quarters, waiting for a dormitory room assignment. It's a stage of uncertainty guaranteed to be terminated for every freshman by the Friday before Registration Day. It arises because, says the *Freshman Handbook,* "M.I.T. is probably somewhat unique in allowing students to select their residence after they have arrived on campus. This process may seem somewhat chaotic, but most people feel that the results are well worth the uncertainty. Past experience has shown that about 90 per cent of the students get their first choice," says the *Handbook*.

Arrive Thursday or Friday

Check in at the R/O Center where you will have your ID picture taken, receive your advisor assignment card, a seminar assignment confirmation (if you requested a seminar), a temporary ID, personal messages, an *MIT Bulletin, HoToGAMIT,* and a whole package of information. At this time, also, you must choose a temporary living assignment and probably deposit any excess baggage for the week.

Check in at your temporary living assignment. If you've arrived early, now might be a good time to browse through the literature you will have received, catch up, or indulge in a little sleep, or ramble around the campus and begin getting to know fellow students.

Take a tour of the Institute.

Friday afternoon, be sure to attend the Freshman Picnic. This is the first official event for freshman, and, besides providing a good meal, gives you a chance to meet fellow students and have a good time.

There will be informal discussion groups just before the Freshman Picnic.

Immediately following the picnic, be prepared for *RUSH!* Whether or not you "plan" to live in a fraternity at M.I.T. you should take advantage of the Rush to get to know more about people, see the Institute and Boston, and enjoy yourself. Be sure to see as many fraternities as you want (a practical limit is probably four or five) during the weekend, because bids are generally made and accepted by the beginning of the week.

You've been bid by one or more fraternities. You now must decide where you would like to live. If you haven't decided by Monday afternoon whether or not you will definitely join a frat, then be sure to file an Institute House preference card at the R/O Center. If you've decided you will join a fraternity, but aren't yet sure which one, then you don't need to apply for Institute Housing.

You're interested in living in a fraternity, but haven't yet been bid by any that interest you. Try to find out where you stand with the houses you like. If you haven't had a bid by Sunday night but are still interested in living in a fraternity you might want to check with IFC to find out which fraternities are still looking for people. You'll want to file an Institute House preference card on Monday just in case . . .

You've decided that you would like to live in a dormitory.

File an Institute House preference form.

You received a bid from a house you like and have decided to pledge.

Pick up your Institute House assignment.

repeat up to three times

You don't like the assignment you got. Put yourself in limbo.

Your assignment isn't ready yet.

You're in limbo. Wait until tomorrow for an assignment.

You've got your housing assignment. Be sure you know when to check in to your permanent assignment.

But in the meantime, go ahead with the Orientation part of R/O Week.

Now comes orientation

In addition to speaking with upperclassmen, reading the literature available to you (the *General Catalogue*, your *Freshman Handbook*, etc.) and speaking with your advisor, be sure to . . .

You should meet your advisor and associate advisor on Tuesday and again on Wednesday or Thursday in order to plan your fall academic schedule.

- attend the Academic Core Orientation, where professors of Physics, Calculus, and Chemistry, as well as Concourse, ESG, and UROP representatives, will be on hand to present an orderly view of the freshman requirements . . .

- and the Academic Midway, where you will be able to ask detailed questions on how to choose the best classes for you and find out about what the different departments offer.

When you have completed your registration material, be prepared once again to relax and take it easy — get to know the Institute and the people around you.

Sunday you and your parents are invited to President Wiesner's Reception. There will also be other orientation events for parents this day.

Check out what tours are being offered that interest you.

In between times, be sure to:

- ☐ Get a Coop card (as soon as possible)
- ☐ Open a checking account
- ☐ Sign for your financial aid (loans)
- ☐ Take any placement tests (they're easy to forget about in all the hustle and bustle of R/O Week!)
- ☐ See the Institute from top to bottom (ask any upperclassman . . .)
- ☐ Sleep!
- ☐ *Enjoy yourself!*

Friday and Saturday will offer a good opopportunity to take care of getting settled into your living group. Be sure to go on the Treasure Hunt on Friday and to the Block Party. There'll be opportunities to see more of M.I.T. and Boston too.

Monday is Registration Day and Tuesday is registration for physical education classes.

However, don't forget to go to the Athletic and Activities Midways, which offer first-hand information and demonstrations of activities available to M.I.T. students.

Then Tuesday, *classes begin!*

Photos on these and the following pages are an abbreviated view of a packed week for members of the Alumni Summer College in Aspen, Colo.: rafting in the Colorado River, lectures and hikes in the mountains, fishing, searching for sample rocks, dinner outdoors on a ranch (in the rain). (Photos: Marjorie Lyon, and page A9, top right: Joseph J. Martori)

Geology in the Perfect Setting: Summer College in Aspen

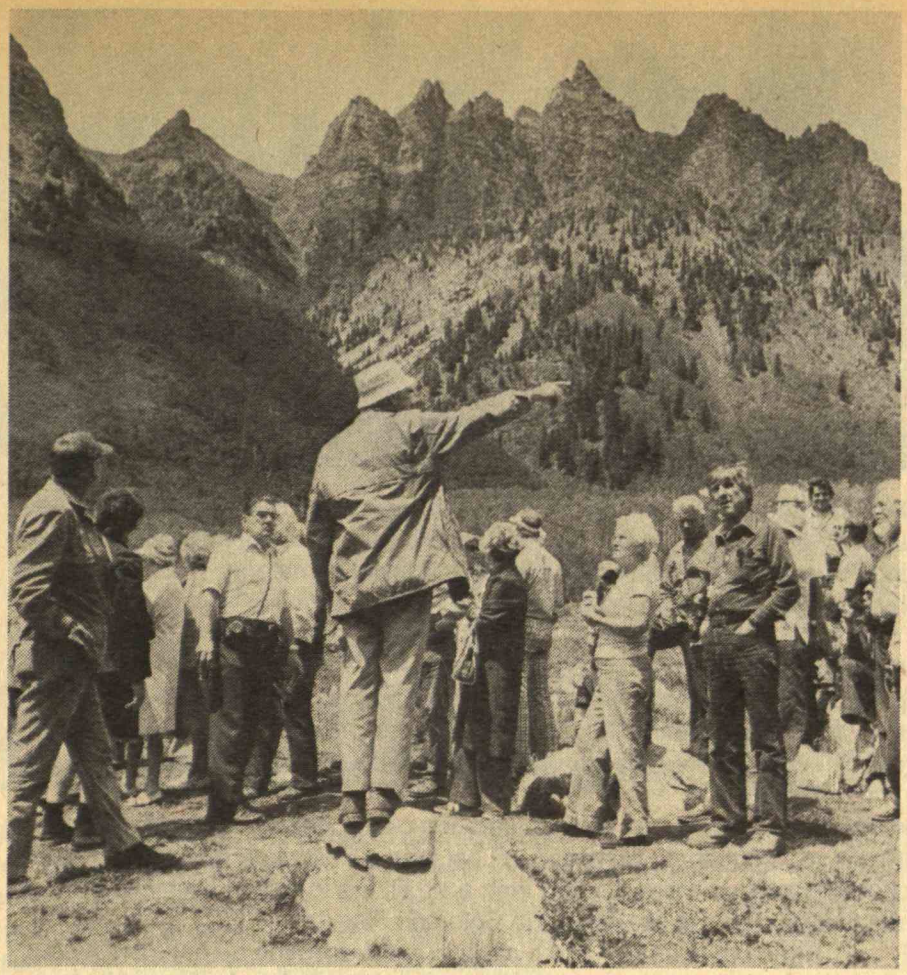
"Oxygen is available if needed over 12,000 feet," came the pilot's announcement over the steady, reassuring hum of the propellers. I noticed from my vantage point directly behind his cockpit (where I could rivet my gaze on his instrument panel) that he was occasionally sucking air from a tube. I mused about the effects of high altitude on me, eyelids growing slightly heavy . . .

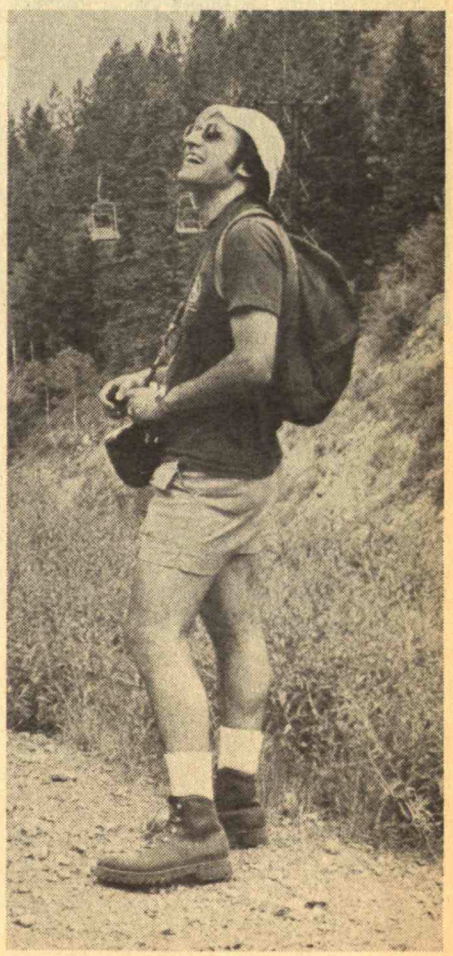
We buzzed through a cloudy dark gray Denver sky over the mountains. They were gorgeous at close range; an absorbing spectacle. Yet I felt some relief — and great anticipation — as we descended into the valley.

Aspen, Colorado, was the setting for M.I.T.'s first Alumni Summer College off-campus, called "Planet Earth, a Monumental Sculpture." The theme — geology — was perfect: Aspen's surrounding mountains invite questions about the earth's formation from even the most casual observer. Certainly they stimulated curiosity and exictement about Earth in the group assembled there for this week in mid-July. ("I'm trying to see it like a geologist sees it," explained one participant as she marveled at the mountain ranges.)

No one knew what to expect.

They came for varied reasons: "I thought if M.I.T. put this together it must be good." "I wanted to see Aspen and I've always been interested in geology." "It seemed like a good opportunity to meet other alumni — we would all have something in common."





Morning, day one. The group of about 100 assembles. There are a variety of ages and professions, only a few geologists. The mood is eager and exuberant in Aspen's thin and (this morning) sunny, warm air.

What is the origin of the earth? Why, indeed, *is* there an earth? What is it made of? How did it evolve? What will be its fate?

John S. Lewis, Associate Professor in Earth and Planetary Sciences and in Chemistry, gave us an overview of our studies for the week.

The basic approach, he said, used to be to take apart the earth into little manageable chunks. Since the 1960s, the approach has been the opposite — to put it together to integrate the pieces into a whole, in an attempt at synthesis.

Planets assert their individuality, said Professor Lewis. Earth is our own unique illustration of the ways in which a certain group of elements reacted in a particular time. A wealth of idiosyncrasy can be generated out of a few basic laws of nature. . . .

During the week these idiosyncrasies of planet Earth were explored in morning lectures, films, and field trips. Resident professors were from M.I.T.'s Department of Earth and Planetary Sciences: Stanley R. Hart, who was responsible for the program, John S. Lewis, Tanya M. Atwater, John M. Edmond, and Patrick M. Hurley (who, having just retired, filled in at the last minute for a suddenly absent faculty member). Participants eagerly sought their knowledge, prompting informal afternoon discussions after formal lectures.

Exclamations were heard as we neared the top of a mountain path to see a magnificent vista: "Look how those plates have moved to form this ridge; see how the changing colors of the rocks on that cliff form a wide, striped pattern. . ."

Monday afternoon: a hike to look at a nearby mountain. Stanley Hart, Professor of Geochemistry, explained the earth's secrets revealed in the rocks lining the path, accompanied by a small chorus of comments, many generated by surprise at our labored breathing in the thin air.

The crowd at Monday evening's dinner, hosted by the M.I.T. Club of Colorado, discussed the day. Those not on the afternoon hike had held impromptu lectures and informal discussions; professors were available to reply to individual questions. The day seemed filled with more than its hours would normally hold — new people, geology lectures, exploration, Aspen.

Children, too, were kept busy: a jeep trip over rocky terrain to Montezuma's Basin at 13,000 feet; swimming in Lost Man's Reservoir; mushroom hunting at Independence Pass, 11,500 feet; a ski lift trip to Aspen Highlands (adults did that, too); a raft trip down the Colorado Rapids . . .

Gray, ominous sky and a chill nip in the morning air gave me a shudder as I stared at the brown swirling water of the Colorado River. My Aspen roommate, Judy, decided to go with the kids on this trip, too (I was to be the photographer), so we exchanged nervous comments about why we had signed up in the first place — and how to hitchhike back along the 40-minute drive from the river to the safety of the hotel.

The guides (outdoorsy-looking, to say the least) gave us explicit instructions: make sure you have your life jacket on correctly; straddle the edge of the raft like a horse and grip with your knees; put all valuables in the wet box (which keeps them dry). Note that everything *not* in the box (you, for instance) will get drenched. (He was right.)

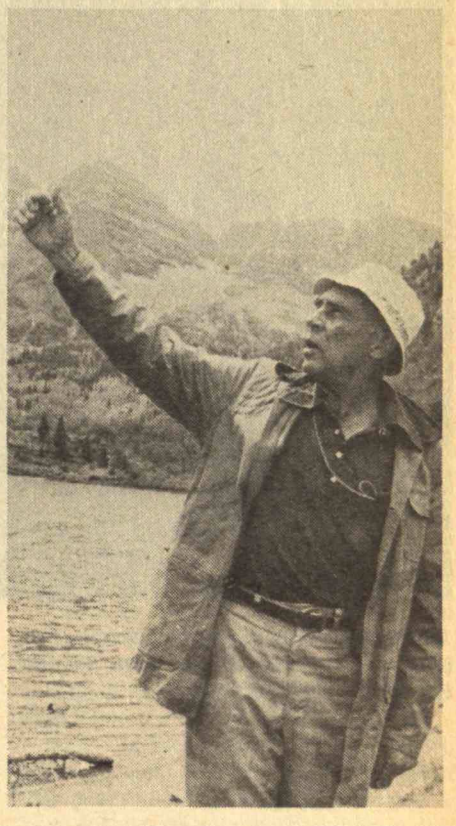
Clambering into one of the rafts, I positioned myself next to the guide. (That seemed a good spot — he seemed to know what he was doing.) He spoke with authority and some amusement at our stumbling ineptitude. "Hold the oars [we each had a paddle] firmly. Push with the top hand, pull with the bottom. Take even strokes. You are my crew, so *let's get into shape!*" (Amazing bravery, I thought, running the white water rapids with a motley green crew of pseudo-adventurers.) "Keep your shoes on . . ." Strange, since one foot was in the water completely on the outside and the other submerged in the inevitable puddle of water in the raft.)

I was excited. And just as we began our journey, dazzling mountain peaks above, the sun lit it all up. (Why have I spent so much of my life in the city?)

"Paddle when we hit the white water" was the order. "Momentum gives us more control . . ." But the water tossed our raft, sometimes backwards, sometimes spinning, sometimes close to the rocky edge. We lost one person over the side, but she was recovered safely. Through it all, Brace, our guide, took good care of his charges.

The sun stayed for the day of a picnic lunch, more bobbing through the rapids, swimming in the calm areas, and a bus trip back with sunburned, tired, still bubbling kids and child-like adults.

Wednesday evening: chuckwagon dinner at the T Lazy 7 Ranch. A constant rain filtering through the giant trees would, one would think, literally dampen the spirits of our group. But we were in high spirits — if a little soggy — serenaded by a country western singer and warmed by a fire, the kids bundled in rain parkas and toasting marshmallows.



Thursday: an all-day field trip to an old mine in Larkspur, then to the Maroon Bells — lovely mountains above a small lake. There a picnic lunch, then divided into groups to go on hikes of varying difficulty. My group set out for Crater Lake. This was the week the Colorado drought was broken — again, it rained. And again our hikers, asked if we should turn back, eagerly pressed on. Even in the dim, rainy air it was beautiful. And we were treated to a discussion of the flowers and rocks along the way by Professors Hart and Lewis.

Near the end of what seemed a very short if packed week, I asked people their thoughts about M.I.T.'s Alumni Summer College. Their mood was exuberant, their comments enthusiastic:

"The staff has been so generous with their time." . . . "There has been so much planned." . . . "I thought I would have free time for tennis and swimming and I find I can do that some other time." . . .

"For the kids every day is a new high — literally!"

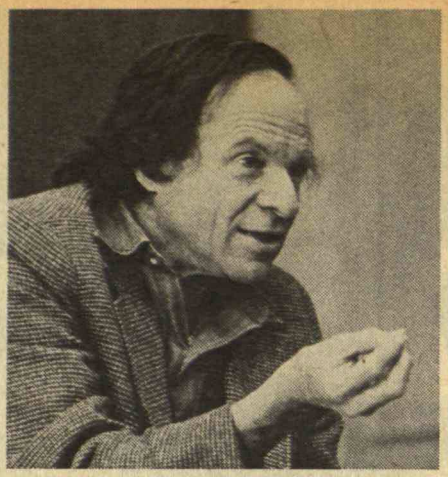
"Every field has a jargon and a mystique to it and much of that has been dispelled now. . . ."

"It greatly exceeded my expectations. . . ."

"I have never enjoyed a week more that I can remember. . . ."

My roommate summed things up, I think, when she said "There's a good feeling here — you can be yourself. (I would never have gone on a raft down the Colorado River in my state of mind at home.) People are at their best in a place like this — they allow themselves to be because there are not outside pressures. You can see things around you that you never noticed before. . . ."

As for me, any time M.I.T. wants me to attend another Alumni Summer College, I'm ready. — *M.L.*



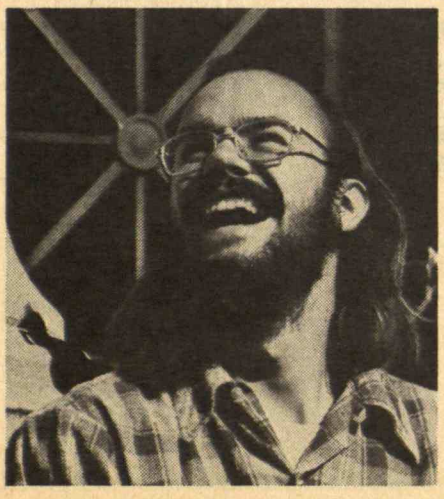
Technique photos by (top to bottom): Paul L. Hertz, '77; William D. Hofmann, '80; and Ephraim M. Vishniac, '78.

". . . If you're Going to be Better Than Anyone Else, You Don't Do it Being Like Anyone Else"

What's it like at M.I.T.?

"Exciting" . . . "instructive" . . . "frustrating" . . . "fulfilling and important" . . . "inhuman" . . . "human" . . . "challenging" . . . "exhilerating" . . . "educational" . . . "tricky" . . . "unbearable" . . .

All these adjectives are in answer to that question published during the summer — in essays by members of the faculty in the 1977 *Technique,* and in essays and quotations from anonymous students in the 1977-78 *Freshman Handbook.* The excerpts on the following pages are decorated with pictures from *Technique,* which Mark H. James, '78, News Editor of *The Tech,* called "the best yearbook published here in recent years. . . . The book's strength comes from the consistent high quality of almost all the photographs," wrote Mr. James, "coupled with a very enthusiastic approach by both photographers and designers. . . . Beautiful and readable," he said.



Technique photos by (above) Jeffrey C. Mogul, '79, and Ephraim M. Vishniac, '78.

"Unsociable . . . Multilingual . . . Automatons"?

"M.I.T. is a really unique and exciting place to go to college. Where else does being multilingual mean knowing more than one computer language rather than being fluent in several foreign tongues? At how many other univerities would it be uncommon to take more than one humanities subject in a term? Yet the stereotype of M.I.T. being a total technical, 'brainy' college inhabited by unsociable automatons is far from accurate."

"Amazing Imagination, and Wit"

"Are we all technocrats? There is overwhelming evidence to intimate that this is not the case. Walking through the halls of my dorm, Baker House, one sees the personality of nearly every inhabitant hanging on his/her door. Newspaper clippings, captioned snapshots, signs, posters, drawings, paintings, writings, and all manner of creativity appear on these appointed showcases of character, often spilling over to the surrounding walls. . . . Then, of course, there's the guy down the hall building a computer in his room, and the architecture students in their studio lofts, and people with amazing imagination and wit wandering every hall."

". . . If you Want to Learn, This Is the Place"

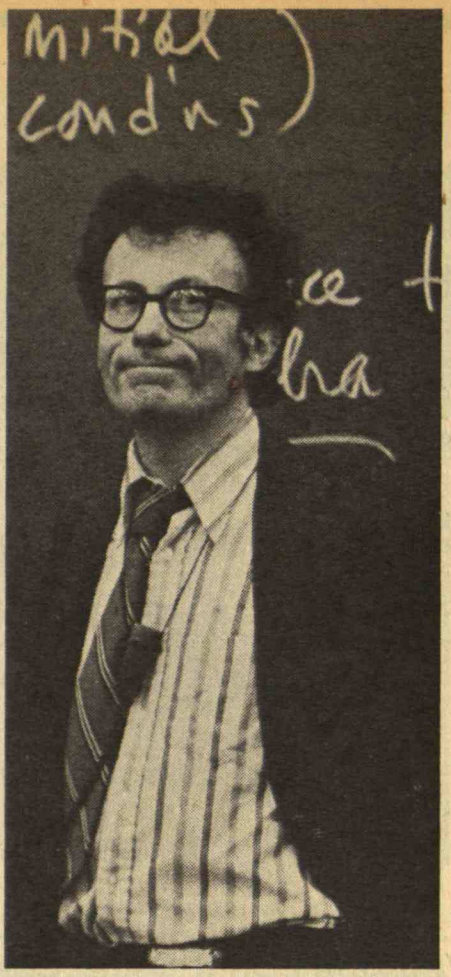
"If you come here hoping to gain in intrinsic understanding of the laws of the universe, you may be in the right place. For example, take the dimension of time. Although before you may have had only a vague idea of what time really is, your perception of it will become strikingly clear when the night before a final you don't have any."

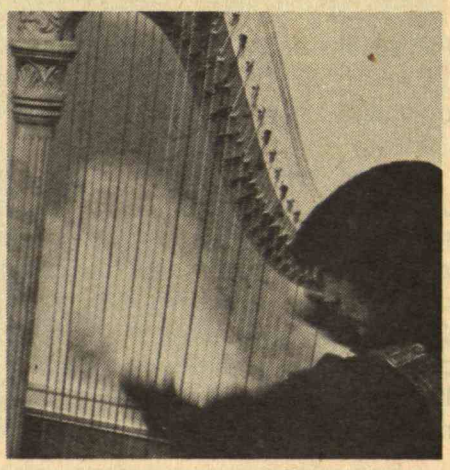
"One of the unique things about life here is that you stay up all night studying and spend all day in classes catching up on your sleep."

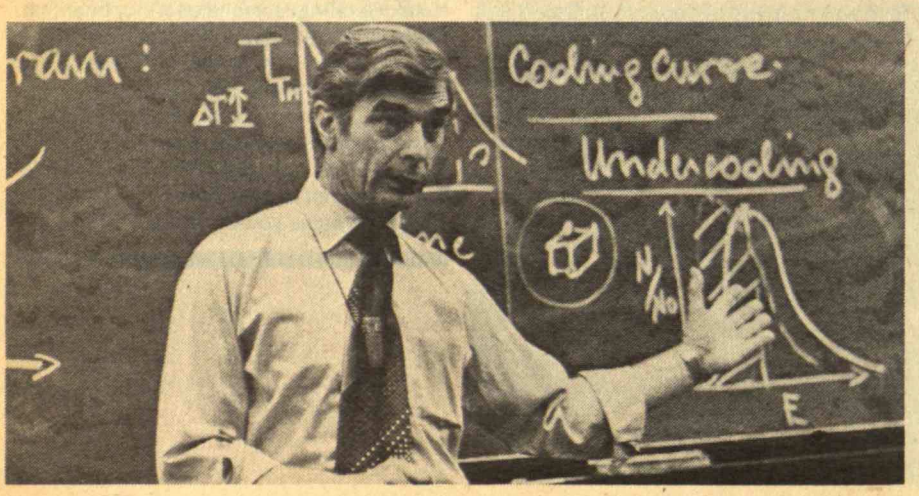
"The sooner you get behind, the more time you have to catch up."

"The work at M.I.T. is tough. Sometimes it's exhilerating, sometimes it's unbearable. Usually, it's somewhere in between. The only thing you can be sure of is that if you want to learn, this is the place."

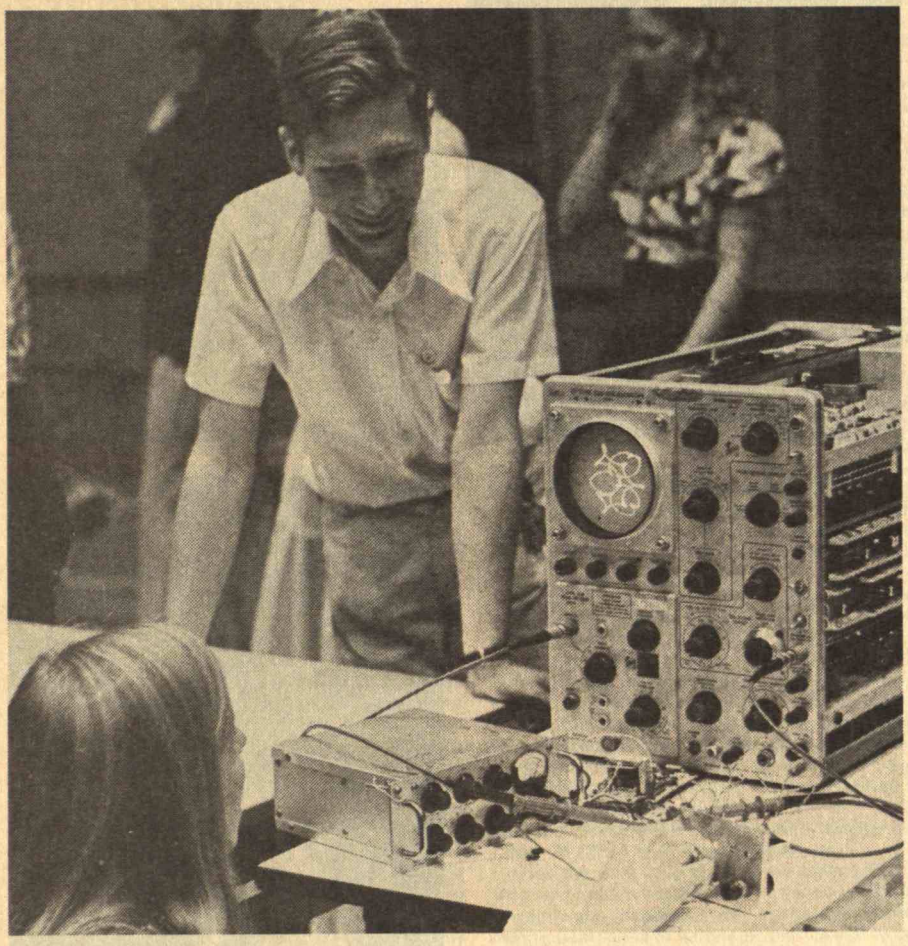
"M.I.T. is tricky. You come in knowing some calculus, physics, and chemistry and they give you a P (pass/fail system) grade. Your sophomore year when you learn new things they give you Bs and Cs."







Technique photos by (center) John W. Lepingwell, '80; and (clockwise from the top): Paul L. Hertz, '77; John W. Lepingwell, '80; Thomas A. Russ, '80; Jeffrey C. Mogul, '79; and Robert M. Brewster, '78.



Technique Photos by (top) Scott D. Tobias, '77, and Marc L. Reitman, '77.

"I wanted a Challenging University, and I Got One"

"There are times when I feel like a real dummy, because I really have to work hard to get passing grades. I never doubted my ability before I came here. I have had to face up to the fact that I'm *not* going to be able to shake things out of my sleeves for the rest of my life. I've never had occasion to doubt whether or not I'm 'right' for M.I.T. And, contrary to a lot of my friends, I've never doubted that M.I.T. is 'right' for me. I wanted a challenging university, and I got one. I'm happy. . . . M.I.T. decided a long time ago that if you're going to be better than everyone else, you don't do it being like anyone else."

On "the Fine Art of Pulling All-Nighters"

"Being a freshman can be lots of fun, but it has its drawbacks. It can be a lot of work, and you have to decide just how much to abuse the freshman pass/fail system. During my freshman year I became proficient in the fine art of pulling all-nighters. This is exactly what it sounds like — staying up all night long — but there are many different types of all-nighters. One night my friend Bill and I, as usual, sat around and talked long into the night. He was attempting to study his Russian as usual, and I was putting up a facade of studying. Every now and then Tom would come out of his room where he had been studying and talk to us, and perhaps get something to eat. This is one of the basic laws of all-nighters: sleep and food are interchangeable to a limited degree. Well, anyway, I don't remember what it was that Bill and I found so fascinating to discuss, but eventually we realized that since were still awake we might as well go to 8.01 lecture, it being 9:00.

"We wandered over to 26-100 and staggered in, 15 minutes late, grungy and unkempt, and not especially refreshed this fine morning. We saw a lone girl sitting in the back row, so to bother the fewest people, we simultaneously jumped over the back of the chairs and landed in the seats on either side of her. She was startled. Bill and I looked at each other, glanced at the figure in the distance scrabbling at the board, said a few words to each other in Russian, opened our notebooks to take a few notes, and promptly fell asleep. Every five minutes or so I would wake up, glance at Bill sleeping, write down an equation or two, and go back to sleep. Bill claims he did the same. After about half an hour of this we finally woke up at the same time. We looked at each other, and without a word closed our notebooks and simultaneously jumped back over the chairs and left."

So Little Time To Think About So Much

Louis Menand III, Senior Lecturer in Political Science (center):
"... The overpowering sense of pre-professional mission permeating the undergraduate program ... has been an M.I.T. trademark from the outset. But in many ways it is now disturbing for many students. ... The certainties of earlier generations have been replaced by uncertainties, and it is crucial for students to sort out intellectually, spiritually, and ethically all of the pressures now operating on them. The ecological effects of technology, the search for values going on all around the Institute, the skepticism toward a life devoted to either "progress" or profits, the ever-increasing demands for a good record to get into graduate school, the uncertainty of one's life goals — all these combine to make the teaching function at times frustrating. This is so because I find that each student who is seeking answers to the ethical questions he or she faces needs *time* to think through and talk through each facet of each question. An educational program so heavily pressuring as the one at M.I.T., while on the whole surmounted by each graduating class of students, leaves precious little time for the kind or rumination and argumentation I suggest. I am sure my frustration is as nothing compared to that of the student going through this search process."

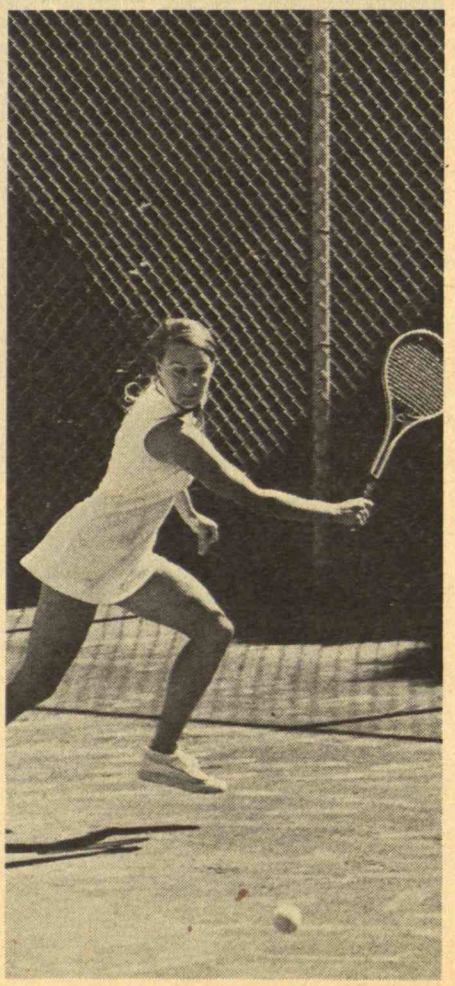
Setting High Standards for the Faculty

Professor Charles E. ("Ned") Holt III, Academic Officer in the Department of Biology (top, right), *on teaching:*
"M.I.T. students usually know right away when an explanation is inadequate. And they usually let you know. One might say that the students set a high standard for the faculty."

Trading Our Insight for Yours

Professor Judith Bostock (Physics) (right) *on teaching:*
"Most of us are idealists and don't believe that a college degree is necessarily synonymous with a college education or that the main reason students should attend college is for better job opportunities. Learning *is* fun. So, mainly, what we as faculty seek is to stimulate and motivate you to inquire deeply into the various disciplines for the joy it will bring you. More than that, however, is that we're selfish; we want to share with you the excitement and the sense of wonder intrinsic to intellectual development, and we want to make a trade: our insight for yours."

Technique Photos by (center) Beth A. Marcus, '77, and Jeffrey C. Mogul, '79.



The new Andrey A. Potter Engineering Center at Purdue University was dedicated last spring to Dean Potter, '03, "a living legend on campus."

03

"And we thank you Lord for blessing us with giants of the earth, who challenge us to be better than we are." Rev. Gary L. Reif, Federated Church of West Lafayette, Ind., thus introduced the formal dedication of the new A.A. Potter Engineering Center at Purdue University, according to the local *News Courier*.

More than 600 people gathered on Friday, June 17, to honor the man whose name has become synonymous with the word "engineering," Dean Emeritus **Andrey A. Potter.**

Housing a Central Engineering Library, an innovative teaching laboratory and study centers, the $6 million building will also serve as a center for research in energy, environment, transportation, and biochemical engineering.

The man of the hour was Dean Potter himself, truly a "living legend" on the campus and indeed in the entire field of engineering. He served as Dean from 1930 until 1953, and even today, at the age of 94 years, he visits regularly his campus office.

George A. Hawkins, Vice President, Emeritus, for Academic Affairs, called Potter a pillar of the University and of the nation. And there was also praise from nine other speakers who addressed the standing-room only crowd in the new Center.

Hawkins said Potter began work in pollution control early in the 1920s; developed a means of washing sulphur from coal and pioneered work on coal gasification and coal liquefacation. Karl H. Kettelhut, builder of the Center, paid tribute to Dean Potter's skill in guiding more than 20,000 engineers from the campus to solve the problems of America and the world.

Purdue's President Arthur G. Hansen said, "Potter always was a man who thought of people first, ideas second, and things third. He has been a wise counselor; a true friend and a constant and continuing source of inspiration for me and many others at Purdue."

The climax of the afternoon came when Andrey, who received his first of many degrees in 1903, rose to unveil the bronze plaque in the foyer of the building: "I wish to thank you and especially the thousands of the alumni of Purdue who have helped to make this building possible," Dean Potter said. "I am sure it will enhance the education of engineers for many years to come. I am deeply touched by this great honor."

A standing ovation followed those words spoken by the man who many say has brought more honor to Purdue than any man now alive. — **John J. A. Nolan**, Secretary-Treasurer, 13 Linden Ave., Somerville, Mass., 02143

09

On Alumni Day the class was represented by only one of its members, its secretary. However, three of the ladies of the class, Muriel Dawes, Margaret Davis, and Madge Spencer attended adding to the class representation. Thursday evening, June 9, we attended the Pre-Pops Buffet in the Stratton Student Center, and then left by bus for Symphony Hall and "M.I.T. Night" at the Pops with the popular Arthur Fiedler conducting. Every seat was taken by M.I.T. Alumni and guests. After the final number, "Sons of M.I.T.," we returned to M.I.T. by bus. We attended the Friday morning sessions when such interesting subjects as "Deep Sea Mining" and "Exploring the Planets" were presented. We were also guests at the informal meeting with light refreshments given by the *Technology Review* where the class secretaries had an opportunity to meet with editorial personnel, particularly with the young ladies who edit our class notes. John Mattill, Editor, was there to greet us and Mrs. Mattill was the hostess.

We next attended the Memorial Service in the M.I.T. Chapel conducted by Rabbi Daniel R. Shevitz, Jewish chaplain of M.I.T. The names of those who died during the past year are listed by classes and those of '09 are as follows: **Edward J. Colgan**, **Stanley P. Finch**, **Laurence C. Shaw**, and **Henry K. Spencer**. The name of **Henry Spencer**, of course, meant much to us as we recalled his long interest in class and alumni activities. For years he was Class Agent.

At the luncheon in Rockwell Cage, the tables for the older alumni were reserved for two or three classes because of their small attendance. It was a pleasure for us to be with the Class of 1912. The luncheon was followed by the usual Alumni Meeting at which new honorary members were admitted and the gifts of the 25-, 40-, and 50-year classes were presented. The out-going Alumni President, Edward O. Vetter, '42, then turned over the gavel to the incoming president, Norman B. Leventhal, '38. (See July/August *Review*.) In the afternoon session the subjects were "Energy and Clean Air, Too" and "Computer Music."

Over the past several years we have reported the many honors bestowed on **Florence Luscomb**. Recently she received a very outstanding honor, having been chosen as one of the "Seven Grand Bostonians." The group included such notables as former Governor Leverett Saltonstall, former U.S. Senator and Ambassador to the United Nations, Henry Cabot Lodge, and Walter Muir Whitehill, the well-known author. At the occasion held at the Parkman House on Beacon Hill, David McCord, an earlier Grand Bostonian, presented a poem which began "So Florence Luscomb, Leverett Saltonstall, . . ," etc. Although most people think of Florence Luscomb, 90, only as a feminist, union organizer, and protester against social injustices, her friend Dorothy Colby was there to say "No one knows Florence 'til they've seen her gardening in New Hampshire where she puts vegetables among the flowers."

We have just received the notice of the death of **Philip H. Chase**, 91, on July 4 in Philadelphia. He was born May 18, 1886, in Hanover, N.H. His grandfather was Professor of Mathematics at Dartmouth College, his father was Treasurer, and Phil (1907) and his three brothers were graduates of the college. At Dartmouth he was a member of a national fraternity, won a varsity letter in track, and won the Thayer mathematics prize. Phil was a very close associate of your secretary at M.I.T. as we were both members of Course VI, and in our professional work during the many years that followed. After graduating from M.I.T. he received a master's degree at Harvard University where your secretary became a faculty member. His life's work was with the public utility industry having first been employed by Public Service Electric and Gas Co. in Newark, N.J., and then by the Philadelphia Electric Co., where he became Chief Engineer and Assistant to the Engineering Vice President. Phil and your secretary, both Fellows and active members of the American Institute of Electrical Engineers (A.I.E.E.) served on several technical committees. Your secretary also was the Chairman and Phil was Vice Chairman of the U.S. National Committee of the International Electro-Technical Committee (I.E.C.) which developed and maintained the standards for electrical terms internationally. There are annual meetings, usually abroad, and Phil and I, with our wives, enjoyed going to them. The I.E.C. celebrated its 50th anniversary at the University of Pennsylvania where Phil was a leader in the arrangements and Theora a hostess. Phil was awarded several United States patents. He was past Chariman of the Philadelphia Section of the A.I.E.E., past President of the Engineers Club of Philadelphia, Chairman of the Association of Edison Illuminating Companies, and Chairman of the Electric Standards Board, and past President of the Pennsylvania Electric Association. His wife, the former Theora Hill Williamson, survives him. They celebrated their 60th wedding anniversary at their summer residence in Kennebunkport in 1973. A large number of family and friends attended. — **Chester L. Dawes**, Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138

10

Our classmate, **John M. Gray**, has been honored as "Executive of the Year" in the construction industry by the Boston Chapter of the National Association of Women in Construction. This took place at a dinner held in Boston last Spring. In their tribute to him they called attention to his long career in the field of architecture and industry and his service in public affairs in the city of Salem, Mass. At 90 years of age, he is still carrying on his business and his civic activities.

John M. Gray, '10

On Being a Freshman in 1901:
"No, Sir" — "Yes, Sir" — "No, Sir"

Rummaging in the files, Gordon Haff, '79, Photo Editor of The Tech, *discovered this recollection of his first days at M.I.T. by an anonymous member of the Class of 1905, published in* The Tech *for October 10, 1901. He reprinted it this fall, concluding that members of the new Class of 1981 might find it intriguing if not precisely relevant; and in turn the Editors of* Technology Review *conclude that it may bring back memories to our readers. It is reprinted here with permission from* The Tech*:*

I wonder if everyone is affected the same way that I was when I went to my first recitation in Algebra. After considerable trouble I managed to find the room where the fatal struggle was to take place. Softly and in awe of the professor sitting upright in his chair at the front of the room, I stole in and slid quickly into the nearest seat.

Shortly after, the recitation began and the professor in low gruff tones asked us to come forward and show our registration cards. Now it so happened, fortunately, I thought then, but unfortunately as I found later, that when I reached the room, the back seat in the corner nearest the door was unoccupied and into that I had crept. But unfortunately that seat was too far away for me to hear a word that the professor said. However on seeing the others start forward, off I started, too, not knowing why. On reaching the desk I very quickly found out it was our registration cards that were wanted. Now unfortunately I had worn a different suit on the day I received my registration card and had forgotten to change the card; so there I stood, the professor glaring at me and wondering why I stood so mum and without my card. All the while I was trying to murmur, "I left it at home." Finally he seemed to catch the last word. "Home," he exclaimed, "well what are you up here for?". "Didn't you hear me say, if you haven't it with you bring it next time?" With sunken head I start for my seat which *unfortunately*, this time, was away off in the corner of the room nearest the door; finally, it seemed ages before I got there, I reached it.

Lucky On Logarithms?

Then the lesson commenced. It had been assigned on a general bulletin which unfortunately I had not seen. However, I soon found out from the fellow ahead of me that it was on logarithms. For the second and last time in that hour I considered myself lucky. Here was my strong point, but I found much to my sorrow that here, too, was my weak point.

"Brown, define a logarithm of a number," growled the professor. Brown couldn't define it to suit him, and neither could the next man nor the next, and at each time the fellows all became more excited. This was visibly augmented by numerous questions from the professor.

Between trying to answer the questions and defining a logarithm of a number each and every member of the class went under. Then the round of the section was started with another question which was finally answered by the fellow next to me. So the next question must come to me.

"Didn't You Hear Me?" "Yes, Sir"

Now I had been unable to hear anything spoken by the professor up to this time but could only guess at what was said by the several fellows trying to answer the questions. Then came the question (I found out what it was later). "What is the number of which 3½ is the logarithm?"

"I can't hear," I murmured.

He evidently didn't hear *me*, for he said, "What's that?" and I, thinking he said, "Can't you?" said "No, sir."

I knew something was wrong for everyone laughed, the professor excepted, *of course*. Then occurred the following dialogue, I answering his questions by "Yes" and "No, sir," as I thought they ought to be answered. Many of them I found out after were wrong.

"Can't you hear me?"

"No, sir."

"What is the number of which 3½ is the logarithm?"

"No, sir?"

"Are you deaf?"

"No, sir?"

"Didn't you hear me?"

"Yes, sir."

"Then answer the question."

"No, sir."

Then angrily, "Sit down."

I heard this last, as it was said more forcibly than the former ones. I had noticed that all the sections were laughing and that — with the successive questions — had so rattled me that I was so confused I couldn't have told my name if I had been asked. I wasn't called on again that hour.

Soon the reciation closed, much to my relief, and I found out then what I had done. Meanwhile I am keeping a wide tract of land between myself and that professor in the hopes that when he finds me in the front seat at the next recitation he won't recognize me.

It is with regret that I include the following obituary: **Joseph P. Maxfield** was born on December 28, 1887 and lived in Escondido, Calif., for 18 years. He prepared for M.I.T. at Salem (Mass.) High School and received the S.B. degree in Electro-Chemistry (Course XIV) in 1910. He remained at the Institute for four years as Instructor in physics and electrochemistry, and then joined the Western Electric Co. (which later became the Bell Telephone Laboratories), where he had a long tenure of office. During that period Joe made many contributions in the field of acoustics, and was responsible for the acoustic design of several large auditoriums in this country. He developed the Orthophonic Victrola, licensed to the Victor Talking Machine Co. and commercial talking pictures, licensed to Warner Bros.

From 1941 to 1945 he was in charge of a research group at Duke University under the Office of Scientific Research and Development for the government. Retiring from Bell Laboratories in 1947, he became Superintending Scientist at the U.S. Naval Electronics Lab at San Diego for five years. Later he was called to the Navy Air Missile Test Center at Pt. Magu, Calif., where he became a consultant, then Acting Chief Scientist until his final retirement in 1959.

He received a meritorious civilian service medal from the U.S. Army in 1947 and one from the Navy in 1953. He was a member of Sigma Xi and numerous other organizations. He was co-author (with Douglas Stanley) of a book *The Voice and its Production and Reproduction.*

Joe Maxfield was always proud of M.I.T. During the latter years of his retirement he became blind and his wife read him many articles about the Institute and Alumni activities. He died on March 24, 1977. He leaves a wife, Milicent, of Escondido, Calif., two daughters, three grandchildren and two great-grandchildren. — **John B. Babcock**, Secretary, 33 Richardson St., Portland, Maine 04103

12

Our 65th Reunion has come and gone and a good time was had by all. The following classmates and ladies were present: **Harold Brackett** and Eleanor Forbes; Helena and **Phil Dalrymple**; Phyllis and **Ham Merrill**; Mildred and **Harold Mitchell**; **Wallace Murray**; **Jonathan Noyes** and Mrs. Randall Cremer; and Julie and **Larry Cummings**. Our thoughts were frequently of those who couldn't make it to be with us and of those who have passed away.

Our first get-together was for cocktails and dinner at McCormick Hall, when we enjoyed having Miss Becky Hoag from the Alumni Office as hostess. President **Jonny Noyes** acted as MC and entertained with a good selection of his many stories.

The next day was a busy one. Breakfast at Stratton Student Center and then by bus to the waterfront for a cruise of Boston Harbor. We were fortunate to be the first group to board ship. No sooner had we selected our seats, than all the kids in Boston began to arrive. Estimates ran from 500 to 5,000. They were an active and restless bunch and covered the decks well with popcorn. With it all, I think we rather enjoyed having them around.

The sights of Boston Harbor were something else again; very depressing; one oil freighter at anchor in the harbor; a couple coast guard vessels at dock and perhaps as many as a half dozen small boats around. Docks were rotting and going to pieces and no traffic in the harbor. Old Ironsides was still on duty, however, at the head of the harbor.

After the cruise, we had lunch at a harbor-side restaurant and then the group split up, some going to Prudential Center to view the city from the sky, others going to their rooms for a siesta. In the evening, Symphony Hall, Arthur Fiedler and the Pops. Arthur put on one of his customary exciting shows.

Friday was Technology Day with a series of programs at Kresge Auditorium, a Memorial

Members of the Class of 1912 at their 65th Reunion.

Service at the Chapel and lunch at Rockwell Cage, where the program included the presentation of gifts to the Institute by some of the five-year classes. The presentation ceremonies were most interesting. At our lunch table we were honored by the oldest alumnus present, John A. Nolan, '03. John was quite a talker and we learned about most of his past life and current doings.

Saturday; on our own for the day with our final dinner at McCormick Hall. **Ham Merrill** and **Wallace Murray** showed pictures of the far east and Russia and **Harold Mitchell** showed some of his bird slides. All were most interesting. We then adjourned to another room where our pictures were taken and a business meeting was held. It was voted unanimously to hold (PLEASE NOTE) the next reunion in 1982. Your Secretary was absent from part of this meeting, but was later advised that the office of treasurer had been added to his duties at no increase in salary. It was also voted that it would be in order for members to send the Treasurer a small contribution to assist in defraying secretarial expenses, such as, office rent, secretarial salaries, postage, telephone, etc. President **Noyes** discussed The Building 10 Fund for the new Alumni Center. Solicitations are being made from classes and individual seats. President **Jon** has appointed **Phil Dalrymple** as chairman of this effort and suggests that, as a class, we sponsor one or more seats at $2,000 each. He reports that several contributions have already been received. You will undoubtedly hear from Phil about this effort.

Your Secretary read letters from **Henry Foley**, **Rock Comstock** and **Cornelius Duyser**. Copies of these letters appeared in the July/August issue of the *Review*.

In addition to our meeting, we were invited to a narration and picture showing of some 50 early years of Technology. This was very interesting.

A couple incidents were most curious and unexplainable. **Phil Dalrymple** had some argument with the back stairs and came in one morning with a big patch over one eye. **Harold Brackett** was found in his pyjamas and locked out of his bedroom at 2 AM. — **L. T. Cummings**, Secretary, R.R. 4, Connersville, Ind. 47331

14

Earle O. Turner died on June 2, 1977, at the age of 84, in a hospital near Harvard, Mass., his birthplace and summer home. He was with us in all four of our undergraduate years and received his bachelor's degree in Course I. Later in his career he was granted a Sc.D. degree. After working for the B. & M. Railroad and serving as a U.S. Army lieutenant in World War I, he joined the faculty of the University of New Brunswick, in Fredericton, in 1919 as professor of civil engineering, became dean of engineering in 1945, and held that position until he retired in 1959. Since then his home had been in Sarasota, Fla. For "outstanding service" in Canadian education, Earle was awarded the Coronation Medal by Queen Elizabeth II. He had been president of the Association of Professional Engineers of New Brunswick and Vice President of the Engineering Institute of Canada. He also received the Institute's highest honor, election by its Council as an Honorary Member. Earle had long been a golfer, and continued to play with cheerful determination even after he had lost an arm to cancer surgery. He had been president of the Royal Canadian Golf Association, the governing body of golf in Canada, and was a member of the New England Senior Golf Association and of country clubs in Fitchburg and in Sarasota. Earle leaves his wife of 60 years, the former Louise Freeman; and a brother, Stanley H. Turner, of Harvard.

Word came from the Alumni Association in August of the deaths of **Arthur P. Shepard** on October 13, 1975; **Lyman S. Baird** on November 6, 1976; and **Perry R. F. Marshall** on May 8, 1977. As further information about their careers becomes available, it will appear in later class notes.

My daughter and I went to Tech Night at the Pops and the Alumni Luncheon in June. We had a good time, but were sorry not to see any other '14ers at either event. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Conn. 06119

15

Azel Mack, Secretary of the Class, continues to progress along the road to recovery from a stroke suffered last May; he'll resume his reports to the Class with the December issue. Meanwhile, he asks that the editors express his appreciation for the flood of messages for good health and good cheer which have come to him from members of the Class. There are more than he can acknowledge individually, and he begs for classmates' understanding and indulgence as he resorts to this general expression of thanks. Mr. Mack is at home, and mail will reach him at Apt. 26A, 100 Memorial Drive, Cambridge, Mass. 02142 — *J.M.*

16

We're happy to begin another year with the Class Notes. **Cy Guething** has for years been encouraging us to "keep breathing." With special pleasure, we report that we had a wonderful afternoon with Cy and Gypsy in early August in Birmingham, Mich., and he is setting a good example for us. They both are doing fine and send their best wishes to all.

Comments on our 61st Reunion — from **Don Webster**: "Fine picture, good fun. We historical characters are still photogenic in our own fashion." **Theron Curtis**: "We all enjoyed the reunion very much." **Doug Robertson**: "Everyone had a good time seeing each other and comparing notes on the past year." **Hy Ullian**: "We enjoyed meeting with all those who were present in the evening." **Paul Duff**: "The annual reunion has become the 'Sinequa Non' for us." **Charlie Lawrance**: "A beautiful event for a marvelous class. Am well, rested, and happy! Breathing well and glad of it." **Henry Shepard**: "Frances and I both feel that the reunion was a great success and hope that we will be able to attend another one next year." **George Crowell**: "It was good to see everybody again, and Bruce, Betty, and I enjoyed the clambake very much." **Francis Stern**: "Thanks for the good care you took of me at our reunion. Gladys' eyes show great improvement, and we are hopeful that early next month (August) the flare-up will be totally healed, so the trip to Boston was worthwhile on her account."

During the summer, we had the pleasure of a visit from Hy Ullian for a tour of our quarry and for lunch. He had started the day with a couple of hours in his office, then drove from Boston for the tour and later returned to his office for another couple of hours of work. He doesn't seem to slow down at all and looks as well as he did 25 years ago. . . . A report on Betty and **Doug Robertson** from Bob O'Brien: they both are doing wonderfully; Doug takes his mile walk every morning and then enjoys all challengers at shuffleboard. Doug and Betty have been enjoying summers at Point Connett in Mattapoisett, Mass., for almost 50 years. . . . **Barney Gordon** also visited me at the quarry this summer. He also continues with a pretty busy routine.

Fred Upton recently wrote: "Maybe I should be getting old. My oldest grandson, in the Coast Guard, got married last year. Two grandsons and two granddaughters in college. What keeps me from getting old is the 14-year-old boy who lives part-time with me and keeps things stirring. He is the youngest of 13 grandchildren, runs a tractor on his mother's farm and also works for me."

Now that we're back on the track and again faced with the pressure of *Technology Review* deadlines, we surely will appreciate hearing from you with news items for the column. Keep breathing and keep writing. — **Ralph A. Fletcher**, Acting Secretary, P.O. Box 71, W. Chelmsford, Mass. 01863

17

The 60th Reunion of the Class was a great success, and heartily endorsed by the 35 class members and 20 accompanying wives who were able to attend. Not all could be present at both Cambridge and Chatham Bars Inn, but for all that, it was a fine representation for a class 60 years after graduation.

Since the response of the five-year classes to attend their reunions was so great, dormitory space was not available for all, so the Alumni Association hosted the out-of-towners in our class at the Sonesta Hotel. This helped us all to become rapidly reacquainted.

Festivities started on Thursday, June 9 with what proved to a highlight of the Reunion. It was a luncheon at Endicott House in Dedham, with five wives of Presidents of M.I.T. as our guests. The four living husbands escorted them, but graciously remained in the background, while we gave to the ladies formal recognition of the significant part they have played in the building of our Institute as we know it today. Margaret Compton, Elizabeth Killian, Katherine Stratton, Elizabeth Johnson, and Laya Wiesner were each presented with a hand-lettered parchment scroll praising their special contribution to M.I.T. and their continued interest in Alumni affairs. Margaret Compton responded for the group and recalled some of the activities of Mrs. Maclaurin, who in her time, had been active at the old Boston Campus, which we knew for three years.

The next event was the breakfast at the Historical Collections, on Friday (Technology Day). Afterwards, we had an opportunity to see the Collections, much of which was reminiscent of our days at the Institute. After the Technology Day luncheon in Rockwell Cage, most of us took off for Chatham Bars Inn on Cape Cod. The trip was memorable for the terrible weather, a real Northeaster, that lasted through Saturday, and confined us pretty much inside the hotel. In some ways this was fortunate for it made for good conversation. Saturday lunch was a Clambake but the poor weather necessitated it being held indoors.

Saturday evening, after dinner, our Class meeting was held and presided over by **Al Lunn.** The Nominating Committee led by **Bob Erb** presented the following slate of new officers, who were duly elected: Honorary President, **John Aleck Lunn**; President, **Stanley C. Dunning**; Vice President, **Richard O. Loengard**; and Secretary, **William B. Hunter**. It was also voted that $50,000 of the Class of 1917 Special Project Fund be appropriated for the development of Room 10-250. The creation of the office of Honorary

RECOGNITION AWARD
PRESENTED TO
MARGARET HUTCHINSON COMPTON

As the active wife of one of the great presidents of the Massachusetts Institute of Technology she has participated in the leadership of the Institute and especially in cementing the loyalty of its faculty, students and alumni. She has become known to some thousands of them for her graciousness, her sincere interest in their welfare, and for her warm personality, all of which has strengthened the closeness of our ties with M.I.T. On our 60th Reunion we are privileged to present this Award of Recognition.

Class of 1917, Massachusetts Institute of Technology

Endicott House
Dedham, Massachusetts
June 9th, 1977

John A. Lunn PRESIDENT

Stanley C. Dunning SECRETARY

Margaret Compton was awarded a certificate of recognition from the Class of 1917 at their 60th reunion for her service to the Institute.

President was in recognition of Al Lunn's long leadership and his significant service to the Class and to M.I.T.

An unusual episode occurred at the same time as our own reunion at Chatham Bars Inn. This was the reunion of the Class of 1957 of Northeastern University. They soon recognized their old Professor of Mechanical Engineering, **Al Ferretti**, among our group and immediately gave him a very warm reception. Al was on the faculty of Northeastern University for many years.

Sunday morning, June 12, we all departed Chatham Bars Inn, in sunshine, and all concluded it had been a very successful 60th Reunion.

Stan Dunning writes as follows: "For those who would still like a color photograph of the Class, taken at Chatham Bars, a few are still available at a cost of $5.00 each. Please send your order with check to Kelsey Airviews, P.O. Box 736, 20 Heritage Ln., Chatham, Mass. 02633."

The compiler of the August Reunion News regrets and apologizes for two identity omissions: not recorded was Bob Erb talking to **Stan Lane**; and in the large group, that is **Al Litchfield** in the back row, third from the right.

Our sympathy goes our to **Henry Strout**'s wife, Ruby, and the **Les Ford**'s wife, Marion, both hospitalized, which prevented them from attending the Reunion.

It was good to have a note from **Ossie Holt** telling of a pleasant trip back to Boston from the Cape, courtesy of Elizabeth and **Ed Payne**, as well as a safe return journey to California. En route, he was able to visit relatives in the Boston area. — **William B. Hunter**, Secretary, 185 Main St., Farmington, Conn. 06032

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It is mid-August and today I walked through the hallowed halls we first trod a little over fifty years ago. They are vibrant with activity in midsummer with students and researchers pursuing their individual activities. As you enter the buildings from 77 Massachusetts Avenue entrance you are impressed with the great number of offices with many secretaries. The Medical Department occupies much space with many patients, sophisticated equipment, and a large staff of specialists. Remember our undergraduate days with Dr. Rockwell giving us one afternoon a week? Much is happening to room 10-250 — more of which in a future issue.

Over these past few years **Herb Larner** has been a most faithful correspondent. In response to my year-end greetings here are some of his thoughts which deserve a careful reading: "Your note asking me to write about happenings since 1918 and my thoughts about the future interests me.

"In 1918, fresh from M.I.T.'s Department of Biology and Public Health, I became an officer of the U.S. Public Health Service. One of my early assignments was to manage a smallpox epidemic raging in Cullman County, Ala. No compulsory vaccination laws existed so by talks and lectures to the people, I had to persuade them to be vaccinated. About 20,000 persons consented to do so. There being few susceptible subjects left for the virus to infect, the epidemic soon subsided.

"Recently the World Health Organization announced that the last few cases of smallpox in the entire world were under control in Ethiopia and that when they had run their course, the scourge of smallpox would be ended forever. Let us hope so.

"Eugenics and genetics have long interested me. They are touchy subjects. Facts are often hard to face, but like it or not, the laws which govern heredity must be reckoned with if trouble in the future is to be avoided in this world.

"Experts on agronomy have learned that if they are to produce superior corn, wheat, cotton, roses, vegetables or what not, they must be guided by the laws of genetics. Animal husbandrymen are aware that if they wish to breed superior farm animals, obtain increased milk or butter fat production, speedier race horses or other desirable qualities in the animal kingdom, they must study the blood lines and be guided accordingly.

. . . "This planet can comfortably accommodate just about so many people and they had better be people of the highest possible quality if we are to have an orderly, well-balanced world in the centuries ahead.

"So I think one great need of the future will be the unprejudiced study of peoples. Alexander Pope put it very neatly when he wrote, 'Know then thyself, presume not God to scan, the proper study of mankind is man.'

"If we desire a better world, we must act. The rules and laws which govern eugenics and genetics must be obvserved and applied in a socially acceptable and humane way. How this can be done in the days to come will be one of the troublesome problems of the future."

My Pacific surrogate, **John Abrams**, writes from the heart and the mind: "Your continued better government pursuits remind me that we are well along in what Director William R. Gianelli, an architect of our vast California Feather River Project, called the 'Nineteen-Seventies, the Decade of the Environment.'

"Years ago Warren K. Lewis called upon the engineering profession to 'strike out and use its competence and its idealism.' Gianelli sought the *true conservationist in industry*. 'He is a man who's been at it a long time; a man who gets his facts straight, is honest, educated and sincere. He uses his brain, not just his emotions. With many more of these people we can move mountains and legislatures.'

"Looking back over the years we find that the 1970 Environmental Protection Act has burgeoned a multi-billion-dollar business and Technology has furnished the solid citizens to administer it. I've told you before that my miniscule engineering contributions have been such that I can still be a supporting member of The Wilderness Society in good conscience.

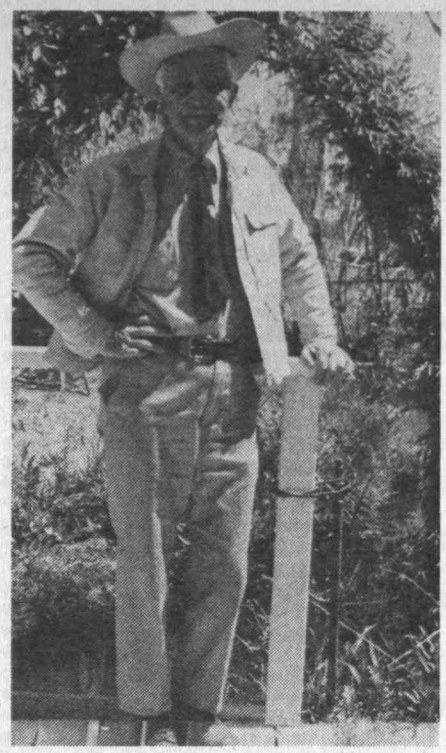
"Finally, with 20 to 30 columns of writing and uncounted hours of protecting our Owens Valley aquifers from its adversary, the City of Los Angeles, all behind me, I'm signing off to work on my mountain brook and keep my faithful water wheel paddling."

We are indebted to the *International Register of Profiles* for a review of **Pete Strang**'s accomplishments: Peter MacDonald Strang was born in 1896 in Scone, Scotland, while his mother was making a visit to her native home. His parents originally emigrated to the United States in 1888. After obtaining a B.S. degree in Engineering Administration from M.I.T. in 1918, Mr. Strang became a supervisor, installing a Punch Card Material Control System, Hog Island, Penn., and in 1920 he became Manager of Ball Bearing Co., and Assistant Manager, Loom-Reed and Harness Co., Spartanburg, S.C. From 1927-33 he was the Senior Cotton Technologist, U.S. Department of Agriculture, Bureau of Agricultural Economics, Washington D.C. Mr. Strang then moved to Massachusetts to organize a project to determine spinning properties of cotton for the Division of Industrial Cooperation at M.I.T. This project lasted for eight years.

During World War II he became Resident Inspector of Ordnance to organize and develop a factory to produce ball bearings for the Norden Bombsight in Danbury, Conn. After the war, he became a research associate, Institute of Textile Technology, Charlottesville, Va., 1945-48; then Research Consultant, Whitin Machine Works, Whitinsville, 1948-60; and Textile Research Consultant, Needham, 1960-75.

His professional memberships include: New York Academy of Sciences, International Textile Service Ltd., American Association for the Advancement of Science; American Association of Textile Chemists and Colorists. Mr. Strang is the codeveloper, with Lawrence M. Keeler-of a method of spinning fibers in a rotating vortex of water at 100,000 rpm which requires 1/1500 power of present equipment whose maximum speed is 15,000 rpm. He is a patentee in the textile field.

For the past decade we have had an annual 1918 mini-reunion in September at Endicott House — with the participation of guests from the classes of '17,'19, and '20. Notices are now in the



John Abrams, '18, poses on a footbridge "dressed up for once."

mail for this year's repeat performance on September 24 with our guest speaker, Professor Alan Altshuler, Dean of the School of Political Science here at M.I.T. We expect this to be a memorable and happy occasion.

We are happy to report **Pete Harrall** and **John Kilduff** recovering from enforced sojourns in the hospital. We expect to see them both at the above-mentioned mini-reunion. — Submitted by **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass.; and **Leonard Levine**, Assistant Secretary, 539 Washington St., Brookline, Mass.

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Word was received of the passing of **Louis A. Brown, Jr.**, 450 N. Rossmore Ave., Los Angeles, Calif., on November 15, 1975.

Fred L. Hunter writes, "I devote all my attention to staying healthy and am succeeding. I'm active and spry at 83." . . . A card was received from **George F. Magraw** of 20 Alton St., Walpole, Mass. . . . Card addressed to **Albert Mayer**, 31 Union Sq. W., New York, N.Y., was returned with statement "Unknown."

A note from **Howard H. McClintic, Jr.**, 8 Howe St., Bay Head, N.J., says he's over 80 and golf is bad enough without a hernia. Can't even try for six weeks. Has three step-children and six offspring. "I see few graduates from M.I.T.," he writes. . . . From **Robert B. MacMullin**, 5137 Woodland Dr., Lewiston, N.Y.: Recently lost our last magnificent elm — 158 rings, just twice my age. Olive's health fair, mine sturdy. I still publish the "Gas Attack" quarterly for the 1st Gas Regiment, W.W.I. We're celebrating our 59th at Aberdeen Proving Ground this fall. I'm still active consulting on matters this generation has forgotten about. My little pocket book *A Walker's Guide to the Niagara Gorge* is a great success. This year hikers by the thousands are enjoying the trips described therein."

Your secretary will be in Maine and Washington, D.C., during September. — **E.R. Smoley**, Secretary, 50 East Rd. 11E, Delray Beach, Fla. 33444

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Our esteemed classmate, **Francis W. Sears** was honored by Dartmouth College at dedication ceremonies for the Francis W. Sears Lecture Hall. Francis was Appleton Professor of Natural Philosophy. At the time of his death in 1975, he had been associated with the Dartmouth faculty, after a 30-year career of teaching at M.I.T. He had authored and co-authored nearly a score of textbooks on physics which attracted well over a million readers and were translated into many foreign languages.

It is with sorrow that I must report the death, on July 20, of our esteemed and beloved classmate, **Herbert G. Fales** at his home, 2201 Central Ave., Phoenix, Ariz. Herb came to Phoenix in 1969 after a distinguished career with International Nickel Co. as vice president and assistant to the chairman. A pioneer in aviation, he was director of North American Aviation, now Rockwell International, for 28 years. At the age of 64 he flew a North American Vigilante at more than twice the speed of sound. He was the tenth oldest active pilot in the U.S. Before joining INCO he had served as an instructor at M.I.T. He became interested in meteorites and was a noted collector thereof. He helped to establish the Center for Meteorite Studies at Arizona State University and was awarded an honorary doctor of science degree at that university. He was a member of the Explorers Club, the Pilgrims, Aviation Pioneers, Kennebunk Beach Chowder and Marching Society, Meteoritical Society, American Society for Metals, and a number of other professional organizations. Herb is survived by his wife, Page, two sons, and six grandchildren. (I am indebted to Roy Allen, '05, for supplying some of this information.)

Julius Wolozin died on May 26. A resident of 200 Mountain Ave., Malden, Mass., Julius was chief engineer of the Groisser-Shlager Iron Works of Somerville, operated by our well-known classmates, **Ben Groisser** and **Abe Shlager**. One of Julius' most important projects was erection of the Esplanade's famous Hatch Shell. He was appointed by Mayor Hynes to serve on a commission to revise the Boston building codes. He was Past Noble Grand of the Lebanon Lodge of Odd Fellows and an honorary life member of the board of directors of Temple Tifereth Israel. He leaves two sons, a daughter, and seven grandchildren.

A welcome letter from **Bill Dewey** to say that Barbara and himself are in good health and Bill plays golf several days a week. The Deweys have nine grandchildren with another due soon. They have been at their summer home in Ashfield, but by this time will probably be in Florida at their Treasure Island place. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

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Greetings to the class as we start our 57th year after graduation. Hope you had a good summer.

A note from **Irving Jakobson** after Alumni Day reported that those attending luncheon that day included **Helen St. Laurent**, **Frank Whelan**, **Don Morse**, **Ed Dube**, **Royal Wood**, Helen and **Bob Miller**, and himself — "the smallest attendance in many years for the class of 1921." **Al Lloyd** was not on hand because of a mild heart attack in May which resulted in his hospitalization for two weeks. Al has made a fine recovery, walks two miles a day and is allowed to go swimming.

A number of letters have come in during the last two months from which it is a pleasure to quote. **Miles Zoller** writes, "Since retirement in 1963 I have been living in Florida, a part of the U.S. that I lived in, way back in 1912-14, and vowed to return to, and did 50 years later. I have kept busy in community affairs and in the study of that most inexact science: economics. Last year we rearranged our style of living, sold our house and bought a condo here and one near San Diego, Calif. From June to November we are near our west coast sons and grandchildren and the rest of the year in Tequesta, Fla. We get the best of two worlds."

Assistant Secretary **Josh Crosby** wrote in early June, "Where has the time gone since you left Sarasota? Win and **Royal Wood** arrived a couple days after you left and went with us to the M.I.T. Club meeting on March 9. Attending were the Woods, the **Herb Kaufmanns**, the **Jim Parsons**, and **Whit Spaulding**. Whit, Woody and I played golf several times with scores not more than 50 over par. The annual Club picnic on Casey Key on April 17 brought out the Crosbys, the Kaufmanns, the Spauldings, the Parsons and the **Helier Rodriguez**es who came down from Tampa. **Phil Coffin** wrote he could not come up to the picnic because he had just had a cataract operation. I talked to **Larcom Randall** the other day and he told me they were undecided about going to Lake Winnipesaukee this summer. Beth Spaulding is finally recovering from her operation and they are flying up to Maine for the summer. Claudia and I were entertained at the apartment of Graciela and Helier Rodriguez this past weekend. Helier arranged for a '21 luncheon while we were there which brought out Becky and **Elmer Campbell** and Billy and **Tom Bartram**." The Crosbys spent the summer at their cottage in Brooklin, Maine.

A brief note from Marion (Mrs. **George**) **Chutter** told of a change in address to 51 Garden View Terrace, Yarmouthport, Mass. 02675. "I have sold the lovely, big house George and I built nine years ago. It was too large for me to care for alone. I am now in a four-room condominium with a patio and my own back and side yards." Marion hopes that '21ers will stop by to see her (phone 362-9334).

Six more letters have come in in response to Assistant Secretary **Sam Lunden**'s request for "life histories" from fellow Californians. Your Secretary will quote from two of these letters this month and hold the others for later issues.

Williston Wirt of Claremont, Calif., wrote: "I came to California when I was married. CalPack was looking for superintendents and I started to climb the ladder. After five years my love for the church took over and I attended the Pacific School of Religion. I got a position as Director of Religious Education at St. John's Presbyterian Church. That was in 1928 and they kept me on through the depression. I became Pastor of the Eugene (Oregon) Congregational Church in 1936, where there was a large youth group. I got interested in folk dancing and helped with the program at the University of Oregon. How it took on!

"I was a military Chaplain in 1943 and ended as a Lt. Col. After the war at the First Congregational Church in Chiula Vista, we were in an area where polio vaccinations had somehow missed. We lost our 15-year-old son. I was called over to Pearl Harbor to erect a church. Later, we were at the Ewa Community Church — an amalgam of Filipino, Japanese, and Haoles. That about covers our career.

"We enjoyed our trip to the 50th Reunion where we met old friends and new ones like Sam Lunden. This year we will have our 55th wedding anniversary. They tell me Tech has added a great deal to my sermons — I never lacked for good illustrations."

Arthur Raymond of Los Angeles sent along a brief summary of an illustrious career. Quoting from his letter, "I got my S.M. in aeronautical engineering under Professor Edward P. Warner in 1921. In 1925 I was hired by Douglas Aircraft Co.; started in the metal shop and then moved into Engineering, doing stress analysis and detail drafting. In 1929 I was Assistant Chief Engineer under Dutch Kindelberger and succeeded him when he left to form what became North American Aviation. I became Vice President — Engineering (1934) and remained in that position until 1960 when I retired. So I was at Douglas from before the DC-1 until after the DC-8 went into service. I had the pleasure of dealing with Charles Lindbergh who was then Technical Advisor to T.W.A., in selling the DC-1. In 1960, after leaving Douglas, I joined the Rand Corp. as a consultant to the President and continued there until 1972."

Arthur has served on several corporation Boards, the National Advisory Committee for Aeronautics for ten years, as a consultant to the Administrator of N.A.S.A. for eight years and in

1947 was President of the Institute of the Aeronautical Sciences. He was elected to the National Academy of Sciences and was a Founding Member of the National Academy of Engineering in 1964. He has received many awards and medals. He gave the Wilbur Wright Memorial Lecture in London in 1951, the Albert Plessman Memorial Lecture in Delft in 1957 and the Lester D. Gardner Lecture at M.I.T. in 1968. His grandson received a doctorate in neurophysiology from M.I.T. in 1969 and is still on the research staff at M.I.T.

The Raymonds have accumulated a large foster family of former foreign students of U.C.L.A. They have travelled extensively around the world and since 1952 have spent many happy days and weeks at Hana, Maui in Hawaii, which has become their second home.

Since the last issue we have learned of four more deaths, which we sadly report: **Francis B. Kittredge** of North Andover, Mass., on May 24, 1977; **William H. F. Rose** of Woodstock, Va. on May 26, 1977; **Edward S. Dennison** of Waterford, Conn., on June 11, 1977; and **Edward W. Booth** of Boca Raton, Fla., on July 14, 1977. Frank Kittredge worked for many years for Jones and Laughlin Steel Corp. in Boston and became Regional Sales Manager. He was active in civic affairs on the Board of Public Works, Veterans Housing, and School Building Commission. He served on numerous boards of trustees, including two banks. In recent years he owned and operated a dairy farm.

Bill Rose was Works Manager for Feigenspan Brewery in Newark, N.J., for many years and hosted steak and beer parties for the M.I.T. Club. In later years he operated a farm in Milford, N.J., until he moved to New Hampshire.

Edward Dennison was Consulting Engineer and Project Director for the Electric Boat Division of General Dynamics.

Edward W. (Scripps) Booth will be remembered as a star in Tech Show while we were undergraduates. He worked for Eastern Refractories in Brookline as Superintendent of Insulation Construction and later as Mechanical Engineer in the Quartermaster Corps. in Natick. In recent years he was a tax accountant in Florida.

The sympathy of the class is extended to the families of these classmates. — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary for Florida, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden**, Assistant Secretary for California, Lunden and Johnson, 452 South Spring St., Los Angeles, Calif. 90013

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It is amazing to look back on the tremendous success of our 55th Reunion and find that everything went just right. We thank **Parke Appel** for his foresight and thoughtfulness in planning so perfect a program and helping carry it through. We were thrilled by the arrangements of the alumni staff and the Institute group in caring for us with room, food and entertainment. We thank those attendees and other classmates who wanted to be with us for their responsiveness and good fellowship. It was all simply great.

Your secretary and roommate drove in on Wednesday afternoon, settled in intimate quarters in McCormick Hall, and joined classmates at M.I.T. Historical Collections. The cocktail party and tour allowed visiting with back-slapping exhortations — you ol'-sonofagun-you. We visited with President Wiesner, Chancellor Gray, our 1922 Professors and Career Development Award holders. After the buffet dinner, Paul Gray brought us up-to-date on M.I.T. Our Thursday program included a boat cruise of Boston Harbor, an Aquarium visit, and luncheon at Stella Restaurant on the Harborfront. Buses took us to Symphony Hall — Tech Night at the Pops — with Arthur Fiedler wearing our red jacket while giving his usual stellar performance.

We enjoyed the Technology Day Program on Friday, attending lectures in Kresge and the Alumni luncheon in Rockwell Cage. Then to Chateau de Ville in Wellesley for cocktails and a dinner theatre production of "Gigi" — all very nicely served and performed. It was a fun evening. On Saturday, our North Shore bus tour and picnic lunch was called on account of rain so a hasty revision called for morning relaxation and class meeting with the picnic lunches to be served in McCormick Hall. For the 55th Reunion Meeting, **Parke Appel** outlined plan changes and encouraged all to join the trek to Spalding Inn Club at Whitefield, N.H., to continue our reunion. Secretary **Whit Ferguson** asked for news of classmates and Treasurer **Buck Eacker** reported modest funds available. **Bill Mueser** moved a thank you from all to President **Appel** and presented a gift to Edna from those present, a silver tray. The Class pictures shown and **Bill Elmer**'s slides of VooDoo will be reported later. They added greatly to our afternoon's entertainment. Greetings were read from Catherine and **Mac McCurdy** of Seattle. Usually we help celebrate their wedding anniversary each June.

The final cocktail party and dinner was beautifully served in McCormick Dining Room Saturday night ending with "We'll see you at the 60th." It was a most worthwhile and well planned four days of pleasure.

Before telling you of the New Hampshire venture with 20 couples of '22ers, we list a few of our class who were with us: **Parke Appel, Harvey Brown, Charles Brokaw, Ray Burrus, Don Carpenter, Lee Carroll, Yardley Chittick, Saul Copelman, Joe Cosgrove, Robert Cummings, George Dandrow, Palma Dickerman, Larry Davis, Bertha Dodge, Shepard Dudley, Buck Eacker, Ray Ellis, William Elmer, Whit Ferguson, Edward Fales, John Goodnow, Larry Gentleman, Norman Greene, Broderick Haskell, Oscar Horovitz, David Harris, Abbott Johnson, Edward Keane, Francis Kurtz, Lachlan Mackenzie, Edward Merrill, Milton Manshel, William Mueser, Marjorie Pierce, Fearing Pratt, Winthrop Potter, Samuel Reynolds, Keith Robbins, Hugh M. Shirey, Abraham Silverman, Randall Spalding, Roy Stone**, Harold Spencer '23, and **William Stose.**

We had lunch with Frances and **Harvey Brown** of Montclair, N.J., and were told about his consulting practice for chemicals and marketing. Harvey's first book in 1957 was entitled *Zinc Oxide Rediscovered*, the second book published in 1977 is a continuation including properties and applications now being published by International Lead Zinc Research Organization of New York City. Their travels included Puerto Rico this year and last year to Florida. We also visited with an author from M.I.T. who won the National Writers Club award for non-fiction. At the Boston Symphony concert we enjoyed watching Mrs. **John Goodnow** sketching our view of the orchestra from close range — mostly backs — from B7 seats at ring-side. Also in our immediate area was **Ed Fales** and **Buck Eacker. Bill Mueser** and **Margery Pierce** with **Frank Kurtz** and **Hugh Shirey** were near us. **Ted Miller** looked very distinguished with Jay and Mrs. Stratton. Marian and **Roy Stone** of Clearwater told us about their enjoyable trip from Port Everglades as the Royal Viking Sea took them around the world in the spring of 1977.

We remembered that **Lester Lewis** wrote the memorial service given at our 50th reunion at M.I.T. as a letter from Helen Lewis told us of his past joys. Lester was a Brown Bagger from Wakefield and Lynn. He taught Industrial Physics and attended the Harvard Divinity School. Lester was in the Radiation Laboratory at M.I.T. and also at the Smithsonian. He later became a minister and now Pastor-Emeritus at Lynn. He has contributed his equipment to the M.I.T. Museum in the name of Class of 1922. We have received regrets from **(Tommy) Wilfred M. Thomson** wishing us all a grand reunion. **John S. Williams** is still working at tennis and spends his summer at Woods Hole. His favorite project now is putting his granddaughter through Williams College. **Lawrence H. Connell** reports that he is recovering from some physical difficulties. The sympathy of our class is extended to the families of **Richard J. Bard**, Bedford, N.Y.; **H. L. James**, Anaheim, Calif.; **David R. Shotwell**, Reading, Penn.; and Dr. **Ronald MacDonald**, Jackson Heights, N.Y.

We hope to elaborate on more conversations and people and our time at Spaulding Inn Club with the next notes. Hang in there for a month. — **Whitworth Ferguson**, Secretary, 333 Ellicott Street, Buffalo, N.Y. 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

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It now seems possible that we shall be concluding our 55th Reunion on Cape Cod in June of 1978. After attending various exercises at the Institute on June 8 and 9 of that year the Reunion Committee has made tentative arrangements to spend the following weekend, that of the 9th, 10th and 11th, at the Lighthouse Inn at West Dennis, Mass. This will allow those who wish to attend the Pops Concert on the evening of June 8 in Boston and Technology Day on the M.I.T. campus on June 9 to spend the following three nights on Cape Cod also, if they so wish. As **Royal Sterling**, our Reunion Chairman who has completely researched all available places on the Cape, declares and is seconded by **Pete Pennypacker,** who has also traveled all over the Cape, it appears to be a truly delightful place right on the south coast with the place, a nice cottage colony, all to ourselves. So far all of the comments that we have received favor the Cape so this is the proposal of the committee composed of **Sterling**, chairman, **Pete Pennypacker**, entertainment, **Rod Goetchius**, golf and **Dave Davenport**, widows. By the time you read this, the first bulletin should be in your hands, depending of course on the publication date of this issue.

We received a letter from **Norman Weiss** who, after regaling us with plans for a family reunion of two married sons and seven grandchildren tells us that he is still doing consulting work. Lately he has been operating as editor-in-chief of the *Mineral Processing Handbook* of S.M.E. and also has been functioning as one of the three Henry Krumb Lecturers of A.I.M.E. . . . We learned of the marriage of **Forrest Lange** to Ada Barr Helmbreck on June 11 last. The wedding was performed at the St. George's Episcopal Church in York Harbor, Me. After the ceremony a reception was held at the bride's home. Congratulations and much happiness, Forrest!

From the newspaper *New Era* of Deep River, Conn., we again hear of the publication of **Pete Pennypacker**'s latest literary effort — *The Vanderloon Twins* (Carlton Press $4.95). We have read the book and find it delightful. Autobiographic in part, it is the story, simply told, of the adventures of 9-year-old Pete and his twin sister, Mary. Those of you from the Philadelphia area will find much of nostalgic interest in this tale which is centered in Haddonfield, N.J.

We received a letter from **Gladys Farmer Noble**, one of our first coeds who studied at the Institute and took part in many activities including Cleofan and the making of costumes for the Tech Show. She reports sadly the passing of her husband, Laurence E. Noble on September 22, 1976. Laurence was a graduate of Harvard, class of 1927. . . . From **Prentiss B. Alger** we learn that he has been obliged to forego receiving the *Technology Review* due to his failing eyesight. He goes on to say that his wife, Frances, also has had her problems with eyesight having had the most fortunate experience of the successful completion of a most difficult and unusual cataract operation. He and Frances recall with much pleasure the playing of bridge with Ida and **Cecil Green** during their undergraduate years. "He (Cecil) did geological survey work during vacations which lead to his employment at 'TI' (Texas Instruments), but he had the executive ability to profit from that opportunity, and his success and generosity proved to be of great benefit to M.I.T." . . . We have a word from **Julian S. Loewus** who tells us that his daughter, Cyd, was married on May 21, 1977 to Washington & Lee University law student, Steven Gary Schwartz. Attenders of our 50th

Reunion will remember Julian's attractive daughter who also attended the various affairs. . . . Just after the Boston *Herald-American*'s pungent expose' of a current coed's opinion of M.I.T. men's sexual prowess, **Roger Cutting** sends us the following: "I went to Tech long years ago, But in a diferent age. / We had our fun like everyone, But not (right) on the front page. / Each lady seemed to have her facts, And I will not dispute her. / But maybe in these modern times, 'Tis all done by computer."

We sadly have six death to report. **Myron K. Chandler** of Waldoboro, Me., died on May 30, 1977. From June, 1923 until retirement in 1964 he was associated with the New England Telephone and Telepgraph Co., serving in various positions including Metropolitan Division Traffic Engineer, General Traffic Engineer, Chief Engineer, Rhode Island, and Chief Engineer, Boston Area. He was active in various community enterprises, Masonic Lodge, Boy Scouts, Lions, Town (Waldoboro) Budget Committee and the Methodist Church in Waldoboro.

Gerald M. Frank of Pittsburgh, Penn., died on September 3, 1976. Gerald received his B.S. and M.S. degrees in electrical engineering at M.I.T. In his career after graduation he organized the Duquesne Iron and Steel Co. and became its president and chairman of the board. His other activities included a brokerage house dealing in iron and steel products, alloys and foundry supplies. He was active in local charitable organizations and M.I.T. Alumni Fund raising.

Per Keyser Frolich died on June 10, 1977 at his home in Westfield, N. J. Born in Kristiansand, Norway, where he completed undergraduate work at the Norway Institute of Technology he taught chemistry and physics there before coming to M.I.T. in 1922 as a Fellow of the American Scandinavian Foundation. He earned his M.S. and Sc.D. Degrees as a post-graduate in 1923 and 1925. During his years at M.I.T. he became associated with Dr. W. K. Lewis, Professors W. G. Whitman and Robert T. Haslam, spending much time and effort in the Laboratory of Applied Chemistry. In his later years he became associated with the Standard Oil Development Co. rising through various responsible positions to Vice President of Research and Development. He held some 75 patents largely on subjects dealing with hydrocarbon products and processes.

Cecil H. Hubbard died on May 9, 1977. After receiving his degree in general engineering with our class he became associated with Reliance Electric & Engineering Co. of Cleveland in Sales and as Manager of Production Planning. Later he joined Towmotor Corporation and became Vice President and later Director of Production and Engineering. After retirement in 1964 he was called back to that company to represent them in their activities in Australia to help resolve their production and engineering problems. He was active in many charitable and public service efforts in his area in suburban Cleveland.

Ralph C. Lockwood died on June 15, 1977 in Sarasota, Fla. He studied chemical engineering at M.I.T. for two years, then spent two years in the U.S. Army Chemical Warfare Section (World War I). He received his B.S degree in Chemical Engineering at Boston University and later studied sanitary engineering at M.I.T. His career was spent with the Bell Telephone Co. of New Jersey from which he retired in 1960.

Harry D. Wolfe of Madison, Wisc., died on March 28, 1977. He was a graduate of Dartmouth College with a B.S. degree and the University of Wisconsin with a Ph.D. in Economics. He studied courses in chemical engineering at M.I.T. He had a varied career in the retail, mail order and manufacturing fields, as well as university teaching and war-time governmental service. He became Market Research Director of Colgate-Palmolive Co. and Professor of Commerce and Journalism at the University of Wisconsin. He was the author and co-author of many articles on business subjects. — **Thomas E. Rounds**, Secretary-Treasury, 990A Heritage Village, Southbury, Conn. 06488

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During our mini-reunion June 10-11 at Old Sturbridge Village, Mass., a replica of New England Living in the 1790-1840 era, a much-needed rain fell. Spirits were not dampened, however, as Class President **Frank Shaw**, **Ed Moll** and Rene had worked months expertly planning the agenda, thereby wetting only our appetites. Ed is our 55th Reunion Chairman, and as a Board member and voluntary technical consultant of the Sturbridge Corporation, gained access to off-limit areas.

We were housed in the famous Publick House and Ebenezar Craft Mansion built in 1750 and used as a station for runaway slaves escaping to Canada. Congeniality ruled the group of **Gordon Billard** and Velma, **Dippy Davol** and Kathleen, **Phil Blanchard** and Besse, **Eric Brater** and Marie, **Roland Black** and Martha, **Clint Conway** and Allora, **George Glennie** and Hazel, **Ed Hanley** and Dolly, **Nate Schooler** and Freda, **Hoyt Hottel** and Nellie, **Dick Lassiter** and Bee, **Frank Manley** and Kitty, **Ed Moll** and Rene, **Frank Shaw** and Barbs, **Dick Shea** and Helen, **Marshall Waterman** and Kathleen, **Don Moore**, **Russ Ambach** and our Honorary Classmate Dean **Irwin Sizer** (Brown '31) and Helen. A plant and card signed by everyone were sent to Lorene **Cardinal** as tokens of our love for her and fond memories of **Paul.** A "Missed You" card was also forwarded to Helen **Maynard** as she and **Perry** cancelled because of illness.

We began our sumptious dinner Friday with an invocation by Russ and closed with an illustrated talk on the founding and early years of Old Sturbridge Village by Mrs. Ruth Wells, who was a participant. Saturday morning we were conducted by Mr. Alexander Wall, President of the Sturbridge Corporation, on an exclusive behind-the-scenes trip to view rare period articles and modern restorative equipment. Lunch followed inspection of many historical buildings and then the rocking chair brigade went into session. A superb roast beef dinner was topped off by slides and a technical talk by Mr. Loren Manbeck on methods of razing, moving and rebuilding appropriate structures in the Village. The evening ended with movies of our 50th at Plymouth, spiced by a run backward rewind, filmed by **Russ Ambach**.

A Technology Day Memorial Service in the M.I.T. Chapel for 1917 Classmates reported deceased May, 1976 to April, 1977, was attended by your Secretary. Present at the traditional Luncheon were **Phil Bates** and Jocky, **Del Kendall**, **Don Fife** and **Herb Stewart** supplemented by six couples from the Sturbridge group.

Frank Manley left Sturbridge Saturday morning to arrive in Suffern, N.Y., as the speaker at the Rockland Community College Commencement, Sunday. Frank was chairman of the organization committee which created the College in 1957, giving it leadership in its critical early years, as College Board chairman until 1962, when he became president of Fitchburg (Mass.) Gas & Electric Light Company. The student body has grown to 8,200, a number of whom have been aided by the Francis E. Manley Student Loan Fund. He says that he is most happy to have had the opportunity of passing on to thousands of others the advantage of a college education.

Vincent E. Lysaght passed away January 31, 1977 at his home in New Rochelle, N.Y. He came to us from Worcester Polytech and received his S.B. in electrical engineering. Vin was a pioneer in microhardness testing and developed a new technique, now considered standard in the metallurgical industry. He authored *Indentation Hardness Testing* in 1949, revised in 1966, and retired as vice president of American Chain & Cable Company, Inc., of New York. Internationally known, he was a frequent guest speaker and life member of the American Society for Metals.

Robert McC. Simonds died September 14, 1976 in East Hampton, N.Y. Awarded his S.B. in engineering management, he earned an L.L.B. later at the George Washington University Law School and became a patent lawyer 1928 to 1942, a flying instructor and then president of the Woodstock, Vt., Country Club.

Alumni Fund envelopes bring messages: **Nish Cornish** from Mexico City — "Had a grand XXIX Annual 'M.I.T. Fiesta in Mexico' last March - this time in Merida, Yucatan with visits to the famous Chichen Itza and Uxmal ruins of Mayan Structures - some 100 visitors plus 60 from our local attended. **John Fitch**, **Gordon Billard** and **Rutilio Torres** represented 1924 (with me!)." . . . **E. Curtis Plant ("Dean")**, now retired in Jersey City, N.J. — "Secretary, Board of Trustees, Christ Hospital; Director, Board of Directors, Statewide Savings & Loan Association." . . . **Hoyt C. Hottel**, M.I.T. professor emeritus, from Cambridge, Mass. — "Occasional lectures on solar energy; membership on M.I.T. research committee in chemical engineering; testimony before Nuclear Regulatory Commission; membership on three Washington committees, occasional substitute teaching."

Luang Videt Yontrakich (nee Punyagupta) from Washington, D.C. — "I wonder how many members of Class 1924 are still living today. What percentage? After a sojourn of six months in Thailand to act as advisor to the Bangkok Metropolitan Government during 1973-74, I returned, since my children were studying here. But I found life is getting harder for a person with fixed pension to sustain even a moderate standard of living. With my best wishes for every classmate." . . . **Dave Evans** takes exception to my recent remark on his Canaan (Conn.) Racqueteers tennis team. Its greatest victory was beating **Ed Dunleavy**'s Piping Rock Club on Long Island for the third time in four years. . . . **Bill MacCallum** and Eleanore's card from Lenningrad, U.S.S.R. notes that their cruise is half over from England, etc., now going to the North Cape (Finland, etc.), then the Azores, St. Croix and back to Los Angeles. Bet they'll head for Cotuit on Cape Cod in a hurry, their cool hacienda.

Cy Duevel passed away the latter part of June, 1977. Reportedly, he was on a fishing trip on the Atlantic, but we are trying to get more details. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart**, co-Secretary, 8 Pilgrim Rd., Waban, Mass. 02168

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A report on our fine showing at Alumni Day, now called Technology Day for some reason, is the first order of business as we begin a new year. The following were at the luncheon: President **Chink Drew**, **Will Gardiner**, **Jim Howard**, **Ed Kussmaul** and Adele, **Ed McLaughlin**, **Frank Mulcahy**, **Milt Salzman**, **Sam Spiker**, **Ed Wildner** and yours truly. A number of us had the pleasure of meeting and talking with Mrs. **Avery** (Frances) **Stanton** who was present with relatives.

Notes have been received from three classmates. **Dan Keck** writes from Myrtle Beach, S.C., to say that following extended hospitalization with a perforated colon he is home and making a gradual recovery. . . . **Tom Killian** keeps active teaching engineering power and stability and doing research at Portland State University in Oregon. . . . **Mary Tripp** says our class notes are too small. The reason is clear. Information about your activities cannot be reported if you don't tell me about them. Mary is working part time and has had her problems since the 50th reunion. She was laid up for many months with an acute arthritis. About a year ago a 21-year-old grandson was killed while on duty with the marines. She proudly announces a fifth great-grandson born in March, 1977. Mary had hoped to make Technology Day but the Society of Women Engineers, in which she is quite active, were holding a National Convention in Cincinnati at that time.

The past summer has brought the unwelcome news that five of our classmates have passed on. From Abbott Johnson, '22, were received clippings noting the passing of **Edward Zetterberg** on April 27, 1977, at Muncie, Ind. Ed had been in failing health for several years as he had reported to me through the Alumni Fund Office. He was a native of Decatur County, Ind. He graduated from

Greensburg High School and served in the Navy during the closing months of World War I. While attending Indiana State Teachers College, he also taught in the Greensburg community. Upon graduation in 1922, he received the Gillum Award in recognition of athletic and scholastic abilities. Following graduation, he came to Muncie and taught two years before entering M.I.T. where he received his master's degree in 1925. He returned to Central High School where he taught chemistry, physics and mathematics, and also served briefly as Dean of Boys. In 1973, in recognition of his service to the Muncie school system, he was honored by having a glacial garden in front of the new Central High School named after him. Ed had spearheaded efforts to create the garden after noting that a group of rocks which had been excavated at the Central site were glacier-borne. He was a lapidary by hobby and had his own rock shop at the rear of his home where he ground and polished semi-precious stones. Ed taught on a part-time basis at Ball State University during the World War II years, and later taught freshman chemistry in 1966 at Ball State. He also was once employed as full-time chemist at the city's sewage treatment plant. His terms on the school board were during the 1950s and 1960s. He served more than once as president of the board. He was a 50-year member of the American Chemical Society and a member of several educational organizations. He founded the Muncie Technical Society, had an interest in photography, and lectured extensively on the subject of rocks and minerals. He was an honorary member of the Indiana Rock and Gem Club. Muncie has lost a well known and highly respected citizen.

Ray Holden, '23, was kind enough to send a short clipping regarding the death of **Bernard E. Groenewold** in July, 1977. Ben was born in Toledo, Ohio, spent many years in the Tulsa, Okla., area before moving to Sarasota, Fla., in 1960. He was a member of the Theta Chi fraternity, the Sarasota Shrine Club, Sarasota Yacht Club and Kiwanis South. He was one of the organizers of the M.I.T. Club of Southwest Florida and served as its president from 1965 to 1967. . . . On June 18, 1977, **Edward D. Murphy** died in Armonk, N.J. No further information is available although you may recall that mention had been made of a note Ed had written me last March in which he told of numerous medications he was taking, so apparently he has been in failing health for several months. . . . **Gilbert T. Loveridge,** who came to the Institute for his master's degree in Chemical Engineering in 1925, died in East Poultney, Vt., on June 8, 1977. . . . Just as these notes were being written a call was received from Mrs. **Ralph B. Norton** in Buzzards Bay, Mass., who informed me that Ralph was stricken while on the golf course and died on April 8, 1977. — **F. Leroy (Doc) Foster**, Secretary, 35 Woodland Way, P.O. Box 331, North Chatham, Mass. 02650

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A mid-August due date for Class Notes requires a little juggling of time. Today and tomorrow there's a big Star boat race known as the Ned Hay Series and boats were trailing in yesterday from all over. Ned was a management consultant from Philadelphia who summered at Rockport and his wife Doris put up a beautiful perpetual trophy in the form of a Sterling Silver model of a Star boat. What does all this have to do with the class of '26? Lots! Doris Hay is **Jim Drain**'s elder sister and classmate **Henry Rickard** is with the Philadelphia firm that Ned Hay started. Doris is coming from California to present the trophy and Jim Drain is arriving in Pigeon Cove tomorrow. Jim's only request was to find a place where he could get good steamed clams — a tough request (no pun intended but did you ever try to eat them?) for a Class Secretary who only eats steamed clams at clambakes, but we have found a place down the highway on the ocean where they are available. Now all we need is to have the fog lift and a little wind for the race.

At the end of July a bright orange VW bus drove up and a most distinguished gentleman came to the door looking for **George Warren Smith**. I looked at him and was sure I knew him, but when? It was **Sterling Pratt** and his wife Charlotte and it had been close to 40 years since we had seen one another. Sterling and Charlotte are now Ft. Lauderdale residents but they spend their summers in New Hampshire. About 30 years ago Sterling bought a farmhouse with some cabins and over the years it grew to a flourishing motel, the "Hannah Dustin" outside Nashua, and is now operated by his son — hence the orange bus with its vanity license plate "MOTEL." Sterling had been reading about Pigeon Cove all these years and vowed to make the visit this summer. It was a grand mini-reunion but unfortunately Ruth was off somewhere for lunch and did not meet them. The next day Margaret and **Pete Doelger** came to town for an overnight visit bringing daughter Charlotte and grandchildren Giovanni and Joyce. Pete usually comes once a year for a visit but his daughter Charlotte, who now lives in Belgium, had not been around for close to 20 years. The visit was short because they were en route to northern N.H. to leave Giovanni at a tennis camp. A handsome family.

I've mentioned that the editing of the Class of '26 videotape was won by your Class Secretary because "he knows so many of the class." In any event the tape is now on three one-hour, one inch wide cassettes and I've had one session at M.I.T. in a room by myself with a special TV set that plays them back. The top edge is numbered by frame and time down to the second for editing instructions. It became more of a project when we were told that color slides could be "dubbed" into the tape. This should allow many more of the class to be included because while I could run all over the place with my camera the video camera required an electrical connection limiting its mobility. With about 75 slides selected for addition to the videotape we hope to get the basic editing completed by Labor Day.

It's now Sunday night and Jim Drain has visited us at Pigeon Cove with his wife and sister — a wonderful visit but too short. Jim has had his steamed clams and if he reads these notes he will know what I think of steamed clams but since he enjoyed them I guess we will have to attribute my opinion to the fact that I was in the neoprene business for too many years. Jim had driven from Pittsburgh in a new car that seemed to please him, a five-cylinder Mercedes diesel. From here to southern Rhode Island and then back to Pittsburgh. Each of these visits is an extra reunion for your secretary.

We regret our next report. **Lyman "Barney" Billings** died at his home in North Andover, Mass., on May 15, of a heart attack. Barney had been with Merrimac Paper Co., before retiring. And on April 18, **Thomas W. Moore** of Houston, Texas, died — we have no details. On this unpleasant note we will say Cheerio, because somehow it has become bedtime for us as well as the Class Notes. — **George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

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Thanks to a late, generous contribution, the 50 Reunion Gift crossed to the seven-digit mark before the deadline. The actual final figure was $1,014,620. The Reunion Gift Committee, and especially **Bud Fisher**, can well be proud of the results of their work.

Congratulations are also due to **Dike Arnold** and the Reunion Committee. It was the best reunion ever, and those of us who managed to get to Wianno, or Cambridge, or both will treasure the memory as long as the Lord spares us. The organization job was superb, with an active schedule which yet left time for visiting with old friends — the best part of any reunion. And the committee had magnificent cooperation from the Alumni Office, which also deserves a vote of thanks.

I counted 66 classmates I talked with at Wianno, and another 22 I saw at Cambridge — 88 in all, of whom 70 brought their wives. I'm sure I missed a number; there were at least ten signed up for the Cambridge events that I did not happen to run into. But even 88 is better than one out of five of the living members of the class — which I think is remarkable for a bunch of septuagenarians.

Chungsoo Oh came all the way from Seoul, Korea, for the reunion. **Avedi Kazazian** came up from Chile, and his wife, Alice, from Tehran, where she had been visiting one of their daughters. **George Cunningham** from South Laguna, Calif., **Bill Kaplan** from San Diego, and **Bert Houghton** from Medford, Ore., were among those who crossed the continent to come.

There was one note of sadness: **George Houston**, one of our most faithful reunion attendants, was too ill to come. George died on July 25, He had had a long and varied career, first with the family real estate firm and during and just after World War II as "mayor" of Richland, Wash., as administrator of all the city's services under assignment from G.E., which operated the Hanford Atomic Energy project in Richland.

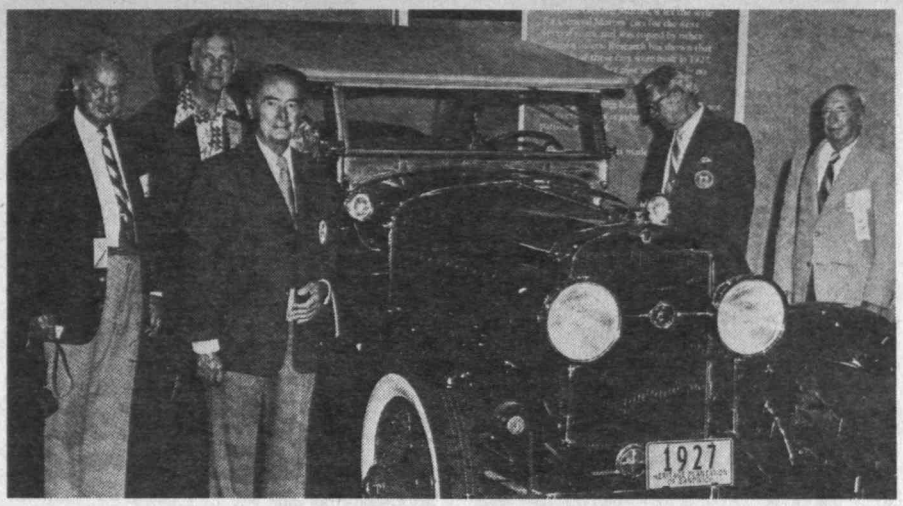
Subsequently, George went back into academic pursuits, as a professor of management at Northeastern University until his retirement in 1971. He is the author of a prizewining book, *Manager Development*. He leaves his wife, Mary, and a daughter and a married granddaughter.

I'll leave the story of the Cambridge activities to the general Alumni Day round-up in the July/August *Review*. At Wianno, the crowd started drifting in on Monday, June 6, and we kept adding to the ranks through Wednesday. The only scheduled activity for Monday was a nostalgic showing of slides and movies of previous reunions. Tuesday was for sports, for the ambitious, with a clambake at night followed by entertainment. Wednesday, after a lunch at the Oyster Harbors Club, most of us drove over to Sandwich to visit Heritage Plantation, with spectacular displays of rhododendrons and other plants, an exhibit of classic autos (more nostalgia), and other exhibits — well worth a visit if you haven't yet seen it. Wednesday night was the class banquet, awarding of prizes, and an absorbing presentation by our classmate, **Harold Edgerton**, of pictures taken with stroboscopic and underwater cameras — including the exploration for the Loch Ness Monster.

At the annual banquet, **Nat Cohn** and his nominating committee offered the following slate of officers for the next five years, and it was unanimously approved: Honorary President, **Jim Lyles**; President, **Bud Fisher**; Reunion Chairman, **Dike Arnold**; Class Agent, **Dick Hawkins**; Secretary, **Joe Melhado**; Treasurer, **Ray Hibbert**; Historian, **Joe Burley**; and Class Estate Secretary, **Russ Westerhoff**. All six officers other than the President and Honorary President were voted the title of Vice President.

Joe Burley quoted some significant statistics on the Class of 1927. As of May 31, there were 419 known living members, 306 deceased, and 61 of whom we have lost track. Only six have attended every one of the five-year reunions: **Arnold**, **Burley**, **Hawkins**, **Lyles**, **Stevens**, and **Willcutt**. Among the 118 classmates who filled out questionnaires, there were 232 children and 457 grandchildren — about as close to Z.P.G. as we can get. (**Lee McCanne**, with six children and 17 grandchildren, brought up the average; **Arthur Connolly** also has six children.) At least three members of the class are great-grandparents: **Dike Arnold**, **Francis Thorne**, and **Atherton Witham**.

Because these notes are already so long, I am going to save everything else for the next issue, except the list of those who attended the reunion. They included: Winifred and **Ned Anderson**, Jean and **Dike Arnold**, Judith and **Milton Bearg**, Nancy and **Fermo Bianchi, Jack Boyle**, Esther and **George Brady**, **Russell Brown**, **Walter Burger**, Ruth and **Joe Burley**, **Bob Carr**, Helen and **Ed Chase**, **Elwood Church**, Marjorie and **Nat Cohn**, Georgette and **Morgan Collins**, **Art Connell**, Gerardine and **Art Connolly**, Ruth and **George Copeland**, Lane and **John Crawford**, Betty and **George Cunningham**, Eleanor and **Larry Day**,



From left to right: Tom Knowles, John Drisko, Joseph Yates, Robert Hatch and Maurice James of the Class of 1927 visit the Antique Car Round Barn at the Heritage Plantation of Sandwich during their 50th Reunion.

Margaret and **Bob de Luccia**, **John Drisko**, Esther and **Harold Edgerton**, Barbara and **Jack Eldert**, Shirley and **Horace Emerson**, Gretchen and **Bob Engel**, Celia and **Howard Ferguson**, Hope and **Bud Fisher**, Paula and **Harry Franks**, Lillian and **Larry Grew**, Kay and **"Steam" Harrison**, Anne and **Bob Hatch**, Mary and **Dick Hawkins**, Esther and **Harold Heins**, Zella and **Ray Hibbert**, Louise and **Ernie Hinck**, **Bert Houghton**, **Paul Ivancich**, Josephine and **Maurice James**, **Herb Johnson**, **Bill Kaplan**, Alice and **Avedi Kazazian**, Rebecca and **Charlie Kingsley**, Marion and **Tom Knowles**, Margaret and **John Kuhns**, Louise and **Hank Kurt**, Louise and **Ted Leach**, Helen and **Bill Lempka**, Molly and **Jim Lyles**, Sylvia and **Lloyd MacAdam**, **Ed McCabe**, Martha and **Lee McCanne**, Marion and **Joe Melhado**, **Frank Meyer**, Mildred and **Lee Miller**, **Nat Mintz**, Pauline and **Harry Moser**, **Shorty Newell**, **Chungsoo Oh**, **George Onishi**, Walda and **Ted Ordman**, **Paul Parker**, Eleanor and **Roger Peirce**, Virginia and **Jack Peters**, Edith and **Charlie Pope**, Alice and **Winthrop Puffer**, Gertrude and **Larry Rasmussen**, Eugenia and **Phil Rhoads**, Helen and **Bill Richards**, Elisabeth and **Percy Richardson**, Sherry and **"Rosie" Rosenthal**, Ann and **Charlie Sanborn**, Irene and **Tom Scott**, Eleanor and **Charlie Smith**, Anne and **Jerrie Spurr**, Dorothy and **Frank Staples**, Rita and **Hank Steinbrenner**, Cecil and **Ezra Stevens**, Katie and **Art Tacy**, Louise and **Dick Turner**, Barbara and **Bob Wallace**, Edity and **Warren Ward**, Kaye and **Russ Westerhoff**, Ruth and **"Pub" Whittier**, Gerry and **Fred Willcutt**, Ethel and **Les Woolfenden**, Hilda and **Don Wylie**, Harriett and **Joe Yates**. I'm sure the list is incomplete, and there could well be other mistakes. If you spot any omissions or errors, please let me know, so I can correct the record. — **Joseph H. Melhado**, Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

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In recent years we have had consistently good attendance of '28ers at Technology Day exercises. This year was no exception. Appropriately enough, there were 28 of us (including spouses) on hand for the occasion.

At a recent awards dinner in Washington, D.C., 60 leaders in the building industry were given quarter century citations by the Building Advisory Board of the National Academy of Sciences, National Academy of Engineering, and National Research Council. Among those so recognized for outstanding contributions was our classmate, **Charles H. Topping**. Until retirement (and a new set of activities) Chuck was an executive with E. I. duPont de Nemours and Co.

A note from **Herm Swartz** enclosed a newspaper clipping that tells us **Tom Larson** was runner-up with an 80 in Class A (70-74) of the New England Seniors Golf Championship held at Braeburn Country Club, Newton, Mass., in June. We also had a letter from Tom saying that he and Lillian are moving from their Cape Cod home back to Summit, N.J. They will continue to spend winter seasons in Florida. . . . In an interesting letter to **Jim Donovan**, **Chuck Carter** tells of browsing through the "Baronetage and Knightage" section of Whitaker's Almanac (British) and noting the name of Sir John Darcy Baker-Carr, K.B.E., C.B., A.F.C., whom many may remember as our classmate in student days.

A brochure recently received via M.I.T. gives us a good description of the highly technical course in advanced reservoir engineering that **Bill Hurst** has been giving in New Orleans, La. It is hard to imagine a more timely and valuable service at this point in history.

We have a few short notes from Alumni Fund envelope panels: **Alexander Daytz** promises to report later on the book he is writing and on his other activities. He and Dorothy will be at the 50th Reunion. . . . **Joe Riley** writes: "I am making what appears to be a good recovery from an operation (in January) for the removal of a brain tumor and plan to drive north to reach our Cape Cod summer home about June (1977). Will be at the 50th Reunion, God willing." . . . From **Dud Collier**: "I had a heart attack in January, 1977 - I am now recovered with a cardiac pacer which is working OK."

A letter from **Myron Helme** says: "Dear Classmates and Friends, how many times since '68 and '73 have Elsie and I reminisced about the good times we had then! We both have run into some medical problems which have slowed us down a lot but are fortunate that we can still take care of each other. We have high hopes of making the 50th. . . . The *Smyth County News* (Marion, Va.) ran a story in the July 14, 1977, edition which begins: "If **Allan L. Tarr** doesn't have a finger in every pie, it isn't because he has run out of pies but because he has run out of fingers." The item then goes on to relate the many social service and business interests that keep Allan well occupied. An interesting point of information mentioned in the story is that the area's local Mount Rogers was named for M.I.T.'s William Barton Rogers. . . . A cheerful letter from **Tex Sandidge** assures us that he will be at the reunion with his wife, Novice, and may even wear a Texas hat with his cardinal blazer.

We regret to report at this time the deaths of six classmates. **James A. Allan** died July 4, 1977. Jim's wife, Virginia, wrote that he had been ill for 13 years and a bed patient for the last two and one-half years. . . . **Henry B. Dean**, Course XV, died February 2, 1977. . . . **Percy E. Harvey**, Course I, died February 12, 1976. His last address was in Clearwater, Florida. . . . **Kenneth G. MacCart** died February 19, 1976. Prior to retirement Ken was President of Petroleum Heat and Power Company, Inc., with headquarters in Stamford, Conn. . . . **Tirso N. Santos, Jr.**, Course I, Graduate School, died April 26, 1977. . . . **George N. Wedlake**, Course IX-B, died in 1976. The information was received from his wife, Lillian. To each of the families we extend our heartfelt sympathy — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, Mass. 01890

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I received a note from the widow of **W. Spencer Hutchinson Jr.**, as follows, "I regret having to write to you that my husband passed away on June 8, 1977. He had emphysema for over 10 years and was hospitalized at the Veteran's Hospital in Grand Junction, Colo., where he died six days after he was admitted at the age of 70. Bill was a mining engineer who studied under his father, W. Spencer Hutchison, who was the head of the Department of Mining and Metallurgy at M.I.T. for many years. He leaves two sons, W. Spencer III, David, and 13 grandchildren." . . . **Edwin H. Perkins**, who retired some years ago from the Bell Telephone Laboratories, is keeping himself busy in civic and other organizational work. To name a few, he is the Chaplain of his Charles C. Dame Masonic Lodge in Georgetown, Mass.; Treasurer, Georgetown Chapter, Order of Eastern Star; Essex County Executive Officer, District 18, U.S. Power Squadron, and others. . . . **Harold M. Weddle** writes, "Thank you for your birthday greeting, which means I am a year older. We are enjoying our retirement years immensely and we can't think of a better place to do it in than Southern California. We try not to let the word get out how nice it is here so as not to attract crowds."

Your Secretary had lunch and spent a few hours with **Howard Pankratz** who had come from California to visit his lovely daughter and family (Mr. and Mrs. Charles Crowthers) in Lexington and attend Technology Day exercises. He is quite well and enjoying his retirement. His wife Margaret did not accompany him because of health reasons. Howard, who worked for Certenteed Corp. for many years, is using his knowledge in asbestos products by acting as consultant to the Chinese government (mainland) showing them how to manufacture water pipes out of asbestos. He is planning to attend our 50th Reunion, but he is not sure that his wife will be able to make it.

An interesting letter comes from **Arnold W. Conti** from his retirement home in the Jacksonville area as follows: "**Jim Fahey** and wife dropped by last month but did not linger long enough to rest up. As usual Jim was on a computerized schedule, he was already running two hours late after being on the road for a week. If he maintains this fast pace, he will surely die young. Sorry we can not join you in a visit to **Robert Pride** and his wife Marion in West Palm Beach. Next week I am tied up at the T.P.C. Golf Tournament at Sawgrass. After that, I am committed to a condominium project in Florida and a savings bank overhaul in Massachusetts. So, I expect I shall be shuttling between Jacksonville and Boston pretty much for the next year or so. As for my sons, one is doing graduate geology work at University of Texas and the other is a soil engineer for Stone and Webster on a nuclear project in Louisiana. . . . As of now, at least, we plan to see you at the 50th Reunion, if not sooner."

Peter Gnoocheff writes, "Thank you for your very much appreciated birthday greetings. I retired three years ago from my profession as an architect, as the firm that I was associated with for 25 years had no work left. Since all other architectural offices were in the same predicament, I did not bother looking for work as I would be competing with hard-working younger men. Now work has picked up again and my chance of reemployment is better, but I am enjoying my leisure too well to go back to work as long as I am able to do it on my social security supplemented with other small income. If I run out of friends,

perhaps I might try working again part-time." — **Karnig S. Dinjian**, Secretary, 10 Ancient Highway, Plaice Cove, Hampton, N.H. 03842

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As of mid-summer when these Notes are being written it seems hardly possible that the deadline for the fall issue is close upon us, but a reminder from the *Review* office assures me that it is. . . . **Bev Ottaway** is one of the rapidly dwindling number of our regularly employed classmates. For the past 47 years he has been working for the Massachusetts Department of Public Works and for the last 20 years has been associated with the Research and Materials Division in Wellesley Hills. He lives only two blocks from his office and holds the impressive title of "Research Coordinator." As many of you know, Bev was active in the Glee Club at M.I.T. He has maintained his interest in singing throughout his life with engagements as a church soloist in nearly every protestant denomination, as well as at a Hebrew Temple in Brookline. He is presently Musical Director of Aleppo Temple Shrine Chanters and Assistant Conductor of the Massachusetts Consistory Choir, as well as a member of several male quartets.

Les Engler retired from the City College of New York as Dean of Administration in 1973. He has since been shuttling between Vermont and Florida, perhaps in some measure due to the fact that he has retired to a recreational area and his children and grandchildren are close enough to exchange visits fairly often. . . . **Joe Kania**, who works for Pemberton Securities Ltd., is still making overseas trips on trade missions for the Vancouver Board of Trade. This spring he visited Singapore, Hong Kong, South Korea and Japan in this connection. It was his 23rd offshore trade mission trip for the Vancouver Board of Trade. . . . **Gergy Smith** was recently elected a life member of the M.I.T. Corporation. . . . **Haskell Small**'s son, who is a concert pianist, is scheduled to perform in the M.I.T. Library Series in March 1978.

Jean Kresser writes that he has been actively involved in a large copper mining project in southern Peru as a power systems consultant on the expansion of a power plant and construction of a new substation, mill, smelter and transmission lines. . . . **Bill Lodge** retired about five years ago from C.B.S. where his last assignment was vice president of the C.B.S. television network. He has retained his home in Hastings-on-Hudson for use as a summer home and now has a winter home in St. Croix. His travel last year included visits to Fiji and New Zealand.

We have at hand a notice concerning the death on April 5 of **Frank Gager** who did his undergraduate work at Penn State but obtained a master's degree from M.I.T. in 1930. He was an instructor in the electrical engineering department at M.I.T. from 1928 to 1933, after which he moved to Boston College as a professor of electronic physics. During World War II he became a staff member of the radio research laboratory at Harvard where he worked on radar jamming technology. In 1945 he joined the Naval Research Laboratory and from 1946 to his retirement in 1973 he headed the Radar Techniques Branch there. He was considered an authority on over-the-horizon-radar. Survivors include his wife Myrtle, their children William and Jane and five grandchildren. — **Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, N.Y. 10036

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These notes are especially difficult to write because of the necessity of announcing the deaths of several of our classmates. With considerable sadness, I report the death of **Ralph Davis**. Ralph was graduated from Wyoming Seminary School for Boys, Kingston, Penn., before coming to M.I.T. He was a past officer of the Alumni Association, a member of Phi Kappa Sigma, a leader of the Pilgrim Congregational Church in Lexington, an officer of the Massachusetts Horsemen's Council, and trustee of the Lexington Trust Co., Lexington. Ralph retired in 1972 from Fairfield and Ellis after serving 40 years; he was Lieutenant Commander in the Navy serving in the South Pacific during World War II. Our sincere condolences to Ralph's wife, Helen, and his family.

John Ness passed away on May 28, 1977. John was a member of the Augusta General Hospital Associates, the Augusta Lodge, AF and AM, Scottish Rite Bodies and Maine Association of Engineers. He was a Navy veteran and retired after 40 years from Central Main Power Co. in 1973. Word has also been received that **Mitchel Barr** died on November 20, 1975, **John L. Turner** on July 12, 1977, and **Jack Wilkinson** on March 6, 1977. No details have been received concerning them. The Class of 1931 extends their sincere sympathy to their families.

Now for more pleasant news. Via ham radio, I talked with **Fred Elser** in Hawaii where he boasted about the excellent weather while we were suffering in a heat wave. If any other ham classmates are interested in joining us, our schedule is at 22:00 G.M.T. on 14, 020 every Friday. . . . **Arnold Childs** writes that he has retired from Sun Oil Co., where he was in charge of marketing research. He and his wife, Rita, spend six months in Thornton, N.H., and the rest of the year in Siesta Key, Fla.He enjoys travel, bridge, mountain climbing, and photography, and since retirement the Childs have made six freighter trips, including several times around the world.

Willis Fleisher, Jr. writes, "Since November, I have been Chairman of the Southwest Florida Chapter 4219 of SCORE, Service Corps of Retired Executives, serving Lee, Collier, Hendry, and Glades Counties." — **Edwin S. Worden**, Secretary, Box 1241, Mount Dora, Florida, 32757; Assistant Secretaries: **Ben W. Steverman**, 260 Morrison Dr., Pittsburg, Penn., 15216; and **John R. Swanton**, 27 George St., Newton, Mass. 02158

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The big event, of course, was the 45th Class Reunion held in June. Rooms were provided for all at Burton House. The special features were the Boston Pops Concert, a visit to Sandwich, Mass., including the Heritage Museum and lunch at Daniel Webster Inn.

Slides of past reunions were shown. There was ample opportunity in pleasant surroundings to renew old friendships and acquaintances and to make new associations. After all, we all knew that M.I.T. shaped our lives in the same period of time.

The committee that made all the arrangements was headed by **Ed Nealand** and **Don Whiston**. Others assisting were: **Bob Minot** and **John Brown**, **Don Brookfield**, **Bill Pearce**, **George Kerisher** and **Melvin Castleman.**

At the class dinner the following officers were chosen for the next five years: **Nick Flatley**, President; **George Kerisher**, Treasurer; and **Melvin Castleman**, Secretary.

It was sad to realize that of the 461 graduating in our class, 227 have died.

Of the 90 who planned to attend the reunion, the following 52 made it. **Fred Alexander**, Maxine and **Wendall Bearce**, Helen and **Phil Benjamin**, Marjorie and **Winston Braxton**, Phyllis and **Don Brookfield**, **John Brown**, Jane and **Ed Burritt**, Ruth and **Melvin Castleman**, Ele and **Alex Daunis**, **Rolf Eliassen**, Dorothy and **John Finnerty**, Barbie and **Nick Flatley**, Sue and **Bob Follansbee**, Georgene and **Joe French**, Marg and **Bob Fyfe**, Mary and **L. William Glowa**, Trudie and **Frank Gowen, Jim Harper, Stan Johnson**, Mary and **Ted Jones**, Isabelle and **George Kerisher**, Dorothy and **Dick Lobban**, Peg and **John Lyon**, Bettie and **Mac MacKusick**, Irma and **Frederick Mader**, Rebecca and **Arthur Marshall**, Polly and **Ed McLaughlin**, Norma and **Martin Meyer**, **Douglas Miller**, Sally and **Jack Millman**, Kay and **Bob Minot**, **Willis Moore**, Betty and **Al Mulliken**, Florence and **George Murray**, Eleanor and **Ed Nealand**, Helen and **Albert O'Neill**, Helen and **Jack Osterman**, Midge and **Bill Pearce**, Win and **Ed Philbrick**, Marion and **Herb Ross**, Marie and **Nick Rothenthaler**, Suzanne and **John Serrallach**, **George Sistare**, Elizabeth and **Ernest Steele**, Jane and **Joseph Stowell**, Louise and **Bob Strong**, **Charles Taylor**, **Harold Tonsing**, **Herb Wagner**, Rose and **Tom Weston**, Bettie and **Don Whiston**, and **Carl Ziegler**.

Please send all communications and news items to me. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, Mass. 01970

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For once I have a bona fide first-page story: Dr. **William D. Harper**, now retired as a practicing chiropractic, missed the notes which were not published in July/August enough to phone 1,500 miles from Hattiesburg, Miss., to find out why, and no one can stop me for considering this to be a compliment. The reasons for omission were explained in an interim letter due for the mails very soon after this is being written, August 14, for November publication. Bill and I were very close as students way back when, and I sure appreciate his call.

Cal Mohr, in his search for **Bob Macy**, wrote to **Emerson Norris** and got back quite an unusual reply — a self-written letter from Emmy. In the summer, Emmy and Christine live in Hiram, Maine, way up high, so that their view in about all directions is marvelous (one must admit that seeing Mount Washington and Portland, Maine, at the same time is unusual. I hope that at least a few of you, friends of Emmy, might take a few minutes to drop him a line, as it is evident that the road back from a massive stroke is long and hard: address R.F.D.#1, Hiram, Maine, 04041. I have a reply to one of mine from **Werner Bachli**, now of Lenox, Mass. He is just about to finish 36 years with General Electric and is now fearful that they might ask him back for two or three months for some special project. The Bachlis intended to spend most of August in the Adirondacks, then back to Lenox and a most enjoyable grind at 9 Old Barn Road.

There is always something to brighten up our otherwise drab lives. This time we find a classmate and wife working for the State of Maryland at the pari-mutual windows, Maryland tracks. The culprits are Dorothy and **Wilbur Huston**. Though retired, Bill has just completed 21 months with O.A.O. Corp., some of the time with his old project, Nimbus. Last fall he took a trip to Belgium, and was amused to see on a billboard an announcement of a musical group who called themselves "Van De Graff Generator." In June he went to Paris just at the time of the air show and the anniversary of the Lindburgh flight.

The grapevine says that **Quimby Duntley** is now retired and has great plans for his retirement. And there are two Fund capsules this time around: **Stan Walters** announces that daughter Janet has just graduated from Acadia University. And **Gerald Kincade** notes that he and Mrs. Kincade were leaving in June, 77, to spend six months in the Philippines, where he is to be consultant to the paper industry, as volunteer for the International Executive Service Corps.

Al Payne, formerly of St. Louis, is enjoying the retirement in Sun City, Fla., travelling a lot to visit daughters in Virginia, Illinois, Texas, and Arizona.

Three of ours have passed to their reward, which is always a saddening time for all of us who knew them. **Wolfgang M. Kloenne**, of the Union of South Africa; **Gorham C. Cluett** of Chatham, Mass., and **Levi S. Brown**, of Arapahoe, N.C. Mr. Kloenne has not been heard from since 1933 and has not ever been back. Let me mention again the real necessity that you arrange to have the Secretary of the Alumni Association informed of the death of any alumnus or alumnae. Please consider that the passing of any classmate is of more than passing interest to many other classmates, not to mention alumni in other classes. I will write to the survivors who have notified us within three months; after that details are too stale.

That's it for now. I have never written a manuscript with less zest than this one. Let's hear from you. — **Warren J. Henderson**, Fort Rock Farm, Drawer H, Exeter, N.H. 03033

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Back on the job again, and thanks to **George Bull** for filling in for me on the last issue. There is some news about the activities of those who are still helping keep the Social Security pot solvent(?) for we retired souls, the loss of one member of the class and some notes from others.

First — the workers. **Felix J. Conti**, who lives in Lexington and is president of T & B Construction Co., Inc., has been elected president of the Associated General Contractors of Massachusetts. Felix has been active for many years in various facets of the Association's work, and this recognition comes as a well-deserved honor. I appreciate him for his thoughtfulness in sending me information about other members of the class.

Norm Krim, who is certainly well known to those who have attended reunions, has been elected president of the Joseph Pollak Corp., a division of Standard-Thompson Corp., and a member company of Allegheny Ludlum Industries. He had previously been general manager of the Boston-based operation. Norm has been associated with Pollak since 1961 — a firm that manufactures electrical components for the automotive and marine industries. He is a former vice president of the Raytheon Co., and a former president of Radio Shack Corp.

Our loss is closer to me than many since I had known him in school. On July 14, **Glen P. Woodbury** died in Reading, Mass., where he lived most of his life since graduating. He served for 30 years as vice president of M. W. Carr Co., retired in 1975 but continued consulting work in retirement. I remember his always cheerful personality and for all the class send our sympathy to his wife Barbara.

Some Alumni Fund notes — one from **Jerry Raphael** who faithfully sends some comments. He's still a "worker" and says; "To Alaska on the Inland Passage last summer — this summer a two-week lecture course on high concrete dams at the College of the Andes, Merida, Venezuela. Still at University of California at Berkeley. Found one of my junior year inked drawings the other day — they sure don't work that hard these days!"

Another three-way contributor (M.I.T., me , and the I.R.S.) is **Peter Kalustian** who writes, "My consultation business has really developed very well with over half as international. My field is in food fats and derivatives. My wife and I have done considerable travelling for business and pleasure. Skiing, tennis, boating and my two grandchildren keep me occupied." In between the "workers" and us "drones," **John M. Thompson** notes: "After more than forty years in the general practice of architecture, I plan to close my office in 1977 and expect to do some consulting work during the next few years I may have left." Everything sounds fine up to those last few words and positive thinking should erase that attitude (unless he's pulling our leg!).

Definitely in the "drone" class like me, **Walter McCutcheon** just says, "Retired from Koppers April 30, 1976 after 42 years." A little more expansively, **George Woodman, Jr.**, writes, "Audrey and I spent nine weeks in Florida starting February 1. Five weeks of this time was spent on Big Pine Key fishing and snorkeling in 82°F salt water." To appreciate the intellect behind these remarks you should know the envelope had a Portsmouth, N.H., postmark and then think back to last winter in the Northeast. If we can just get George to tell us his future winter vacation plans, we can forget about looking for wooly caterpillars!

Speaking of vacations, I will report briefly on the trip we had in May and June. It began in Rome and we had ten days of intensive but enjoyable sightseeing in Rome and Florence, Jane getting a big thrill out of seeing the original art she had studied in college. The Sistine Chapel in the Vatican museum lived up to its promise but one of the most impressive things about St. Peters, to me, was that the wall decorations were not paintings, not frescoes, but mosaics! However, all the walking on stone and the marble floors of the art galleries almost put Jane out of action. Things eased up when we went to Como and Luzern and we had time to go to Interlocken and ride some of the cog railways towards the Jungfrau. In England we had some good days in London — got to Greenwich and Zero Meridian and then a good weekend in York for the Minster (half of the medieval stained glass in England), the new railway museum, and the Castle (historical) Museum. We then rented a car to go into Wales — saw my narrow gauge railroads, lovely countryside with acres of rhododendra in bloom, and hordes of people because it was Bank Holiday weekend. We had some fun when we were stopped by a policeman in a small town because the registration had expired four months before. He couldn't have been pleasanter when he found it was a rented car — I doubt if we would have been treated as politely here. Back in London for the Jubilee events the weather turned bad on us, overcast and "off and on" drizzle. Even so, the crowds were tremendous and we got chicken and stayed in the hotel, watching on the "telly" on the not-so-nice theory that the Queen was getting paid to be rained on but we weren't. The really impressive thing was that, with all the nuts loose in this world, she could (and obviously wanted to) walk so freely among the crowds. I'm afraid if an American president tried that, the Secret Service would be having heart attacks by the dozens. It was another great trip, hope we can find the wherewithal for another one in a couple of years. — **Robert M. Franklin**, Secretary, Satucket Rd., (P.O. Box 1147), Brewster, Mass. 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Chevy Chase, Md. 20015

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We had a very fine gathering of '35ers for our mini-reunion on Technology Day at the Faculty Club . . . cocktails, dinner and much socializing plus a most pleasant surprise impromptu entertainment by **Bernard Whitman**. He is a magician of note of whom I have written previously. After several curtain calls he agreed to provide the entertainment for our next reunion on Technology Day, 1978. Keep it in mind so you can plan to join the following who attended this year and will be back: Betty and **Leo Beckwith**, Florence and **Ned Collins**, Agnes and **George Forsburg**, Ida and **Macklen Kleiman**, Elsie and **Hank King**, Doreen and **Allan Mowatt**, Rhoda and **Bernie Nelson**, Jane and **Pete Grant**, Jinny and **John Taplin**, Evelyn and **Vinton Ultrich**, Jeri and **Bernard Whitman** plus **Rufus Applegarth**, **Randy Antonsen**, **Willard Bix05**, **Clark (Nick)** and Eleanor **Nichols**, and **Phoenix** and Sara **Dangel**. I was glad to take advantage of the evening and catch up with what some of our classmates had been doing.

Pete Grant retired from the M.I.T. Alumni Association on June 30 after at least ten years there. . . . **Ed Woll** has received another award. This one is the Air Breathing Propulsion Award made annually by the American Institute of Aeronautics and Astronautics and presented to him on July 12th in New York. . . . Since 1955, **Willard Bixby** has lived in Novelty, Ohio, (near Cleveland) and been employed by the B.F. Goodrich Chemical Co. where he is currently a technical consultant in Process Engineering. He and his wife Jeanne have five children. Ellen, their first, is single and busy in a real estate management company in her home area. Richard, next, is going into his fourth year in computer science at Purdue; Kathy is spending a year in Venezuela in "Up With People". Jim just graduated from high school and enters Cornell this fall, while Cindy is going into the 9th grade. Willard has changed very little in looks from his days at the boathouse 45 years ago. . . . Eleanor and **Clark Nichols** drove down from Searsport, Maine, and their new home after 41 years in the Philadelphia area. Nick retired from Leeds and Northrup in July, 1976, after those 41 years. He is currently a Trustee of the Penobscot Marine Museum and Treasurer of the First Congregational Church. They have three sons: Daniel is married and lives with his wife in Silver Springs, Md. He received his civil engineering degree from M.I.T. in 1968 and is now a naval architect with the Naval Ship Systems Command in Washington. Theodore ("Ted") received a B.A. in economics from Lafayette in 1970. He is with the Fidelity Bank in "Philly" and lives with his wife in Secane, a western suburb. Andy is a civil engineering graduate from Princeton in 1972 and received his M.B.A. from the University of Maine in 1977. He works for Portland Pipe-Line Co.

At our mini-reunion there was much discussion as to where we should have our 45th Reunion. **John Taplin**, **Rufus Applegarth**, **Vince Ulrich** and **Pete Grant** were chosen to generate information and suggestions for the location of our 45th and report back at the next Technology Day reunion in June, 1978.

The following notes came through the Alumni Fund Office. **Charles K. Allen** notes that he retired as a colonel from the Ordnance Corps and is an active licensed mechanical engineer in New York State. . . . **Robert Spinney** writes from Pearce, Arizona, "Have now retired from teaching which I started after retiring from the Bell System. Keep busy as district fire chief, ambulance driver, director for a distribution electric co-op, director for an electric co-op and director of a credit union. Am Master of my Masonic Lodge, High Priest of Royal Arch Mason Chapter and Generalissimo of Knights Templar Commandery." . . . **Jack Holley** passes along the following words of wisdom: "Hi Guys. Still kicking although I face retirement October 1. I plan to stay active — do something — sell bridgework, even — but stay active somehow. My beauty salon is not doing well so I'll probably get out of that line. Drove to Connecticut via Tennessee and back via Colorado recently. I want you all to remember how old you are so get with it and have fun before it's too late." — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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Alumni Day activities in June attracted many familiar faces and, as always, a few who have not been seen for some time. Evelyn and **Charles Mueller** came up from Princeton, N.J. He retired last spring from R.C.A. and is currently A.I.E.E.E. Awards Chairman for electron devices. . . . **John Zietlow**, who took only a few courses, came up from Martha's Vineyard where he summers. He has made his home in Buffalo for some years. . . . **Elliott Robinson** attended the civil engineering social hour and dinner in Walker Memorial and reported on the phone the next day that **Art Carota** and **Frank Schoettler** in Boston on business had both been present. Both are involved in construction; Art in Wilmington, Del., and Frank in Louisville. It was the first time Frank had been back to the Institute since graduation! Also on hand were the **Dashefskys** and the **Chappers**, Vivienne and **Eli Grossman**, the **Coopersteins** and the **Kramers**. Listed as attending, although I did not see them, were Dr. **Charles Rife** and **William Metten**.

With their contributions to the Alumni Fund came news of the following: **Bernard Gordon** is with Woodward-Clyde Consultants in San Francisco, and works mainly in the Western U.S. They are consulting civil engineers and geologists specializing in soils and percolation studies. . . . **George Hain** retired a year ago from Cities Service Co. Whether he has moved he doesn't say, but his check was mailed from Las Cruces, N.Mex. . . . **Roger Krey** spent four weeks in Great Britain in the spring and reports great admiration for the 125-mph trains. He wonders when U.S. rail technology will catch up.

Henry McGrath received the Chemical Pioneer Award of the American Institute of Chemists last March in New Orleans. The citation reads "for his pioneering roles in the development of the modern synthetic ammonia process and in the conversion of coal to gasoline." . . . **Winthrop Scott** reports that he retired from Boeing Commercial Airplane Co. in 1975 after 18 years of working mainly on 707 and 747 planes. He is now working on small airplanes, including two new replacements for the Republic Sea Bee amphibian. He is employed as a consultant by Astel

Engineering but took off enough time for a four-week visit to Spain.

Bill Orrison, a graduate member of the class, wrote me for some information which I have tardily provided. His letterhead reads: "William Orrison Engineers and Associates; Civil, Structural, Traffic; San Antonio, TX." He reports that he and his wife, Mary Elizabeth, are the proud parents of three nice people. Their oldest is an ophthalmologist with the Air Force in Wichita Falls, Tex. A daughter is working as a translator and coordinator for a group of doctors at Stanford University who do charity work for patients from Mexico, Central and South America. The youngest, a second daughter, has her master's in regional planning and is employed by the City of Houston. Since all three are unmarried Bill and Mary Elizabeth "envy people with grandchildren." There's plenty of time, Bill!

Meanwhile your secretary is sticking closer to home for a bit and will be delighted to hear from or see any of you. The latchstring is always out. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

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Over 60 Members of our class plus their wives attended our 40th reunion on campus at Burton House in June: Pogo and **Bill Bergen**, Jean and **Charles Cardani**, Barbara and **Fred Claffee**, Mabel and **Wells Coleman**, June and **Huck Comley**, Marie and **Ed Corea**, **George DeArment** and Janet, Mary and **Charles Dierksmier, Ruth and Phil Dreissigacker**, Olga and **Evan Edwards**, Mary and **Joe Engel**, Bette and **Jim Ewell**, Gioconda and **John Fellouris**, Dorothy and **Bob Ferguson**, Loretta and **Fred Ferrary**, Alyce and **Ernest Ferris**, Elizabeth and **Earl Fraser**, **Dick Gidley**, Carrie and **Bob Glancy**, Irene and **Frank Goddard**, Betsy and **Herb Goodwin**, **Bob Harris**, Marion and **Joe Heal**, **Ed Hobson**, Betty and **George Hunter**, Alice and **Win Johns**, **Margaret Mace Kingman**, Pearl and **Les Klashman**, **Nancy Klock**, **Frank Lewis**, Rose and **Milton Lief**, Elisabeth and **Bill McCune**, Peggy and **Dave McLellan**, Mary and **Bob Morton**, Rosemary and **Gil Mott**, **John Nugent**, Kay and **Jim Pearce**, Ruth and **Phil Peters**, Ruth and **Ed Peterson**, Janet and **Harvey Phipard**, Grace and **George Randall**, Pearle and **Pete Reitz**, Dorothy and **George Rosen**, Irene and **Bernie Ross**, Joan and **Bob Rudy**, Lucy and **Irwin Sagalyn**, Abbie and **Jerry Salny**, Annette and **Leonard Seder**, Rachel and **Albert Shulman**, Ginny and **Jack Simpson**, Martha and **Joe Smedile**, Dorothy and **Hank Stern**, Ruth and **Eric Swenson**, Rose and **Bob Thorson**, **Jervis Webb** and Patricia Lyeth, Florence and **Ralph Webster, June and Walt Wojtczak**, Dorothy and **Albert Wynot**, Marge and **Dick Young**, Anne and **Stan Zemansky**, Agnes and **Art Zimmerman**, Ann and **Michael Zinchuk**.

At the Technology Day luncheon our reunion gift chairman, **Dick Young**, presented to the Institute our gift of $467,327. On Saturday we spent a rainy day at the Essex Country Club, but a few hardy souls played golf and all agreed the lobster was excellent. At a class meeting held on Sunday morning at Burton House, the incumbent slate was reelected after much campaigning: President, **Phil Peters**; Vice President, **Dick Young**; Secretary, **Bob Thorson**; Assistant Secretary. **Les Klashman**; Treasurer,**Joe Heal**; Class Agent, **John Fellouris**; Class Estate Secretary, **George DeArment**; 45th Reunion Chairman, **Dick Young**; Chairman of the 45th Reunion Book, **Nancy Klock**. The reunion then ended and all present agreed it was one of our best.

Nancy has already started on the 45th Reunion Book and will be contacting the class members for data. At our 40th we had no reunion book and all agreed that a reunion book is worthwhile and is valued by all who attend and especially by those members who cannot make the reunion.

Les Klashman underwent heart surgery right after our reunion, and I am happy to report that all is well and Les is recuperating at his home, 198 Maple St., Malden, Mass., 02148. In fact, during his recuperation he is working on a new card to remind you members to send us material for the class notes.

It is with deep regret that we learned of the death of **Martin M. Kuban** on March 21, 1977. Our sympathy goes to his wife Lorraine and his family. — **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, Mass., 02155; **Lester Klashman**, Assistant Secretary, 198 Maple St., Malden Mass., 02148

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If you are ever on the Mississippi River and see the M.I.T. Eager Beaver on a tow boat going upstream, you will know that it is a boat belonging to the National Marine Service, Inc. **Dave Wright**, who is the President of National Marine, just sent me a booklet commemorating the 50th anniversary of the Company, which was started by his father in 1927.

For this issue, most of the news seems to be either awards or retirements. First, the honors: **Ascher Shapiro** has been awarded the highest honor of the American Society for Engineering Education, this being the Lamme Medal. The award is bestowed for excellence in teaching and for contributions to the art of teaching. As you know Ascher is an Institute Professor at M.I.T. in the Department of Mechanical Engineering. **Haskell Gordon** was awarded an honorary degree at the commencement of Worcester State College. While most of you are aware of Haskell's service to M.I.T. and more particularly to the Class of 1938, you may not be aware of his very extensive community activities in Worcester, where among other things he is Vice President of the St. Vincent Hospital Research Foundation, a member of the Campaign Cabinet of the United Way, a member of the Board of Trustees of the Worcester County Mechanics Association, and President of the Worcester County Music Association.

Nick Barbarossa is now self-employed as a water resources consultant. The Agency for International Development sent him to Yemen as part of a three-man team for a six-week stint this last summer. **Curt Torrance** spoke to a Conference on Energy for the North Carolina Consulting Engineers' Council this last summer. Curt is presently the local manager for Charles T. Main Co. in Charlotte, N.C. **Russ Colle** writes that he returned a year ago from England where he had been for three years in a village between London and Oxford. Russ was on the staff of the Commander of Naval Forces doing operations research.

I recieved my annual note from **Bill Gibson**, who is still teaching economics at the University of Baltimore and the University of Maryland. This is all very phony, because he is really retired and spending all of his spare time sailing.

I earlier mentioned retired people. **John Petroskas** writes that he retired from Phoenix Steel; nevertheless, he is staying active in the American Society for Testing and Materials. He makes a hobby out of history and more particularly the history of the early colonies — the way they lived and the way they manufactured iron. Another retiree is **Charles Donlan**, who left N.A.S.A. in 1976 after 30 years of government service. Charlie had been Deputy Director at N.A.S.A.'s Research Center and then went to N.A.S.A. Headquarters as Deputy Administrator for Manned Space Flight. **Howard McMurray** wrote that he retired last spring from the New Jersey Zinc Co. after about 30 years with their Mineral Exploration Group.

Along with the good news goes bad news: **Richard C. DeLong** died earlier this year.

This is early fall, and it is hard to believe that next June we will have been away from M.I.T. for 40 years. A committee headed up by **Dave Wadleigh** is presently planning our activities for our 40th Reunion. **Norm Leventhal**, **Ed Hadley**, and **Haskell Gordon** have been very actively involved in this. Mark off on your calendar June, 1978, for the 40th Reunion, and I will see you all there. — **A. L. Bruneau**, Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y. 10005

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Bill Babcock is Professor of Civil Engineering at North Carolina State University and he was especially honored by election to the University's Academy of Outstanding Teaching. . . . **Jim Barton** and Mary just returned from another trip to Europe where they were making some contribution to Boeing which recently declared increased earnings and split its stock two for one. . . . Billie and **George Cremer** also have activities in the department of peripatetics and sent cards from the Far East.

While on a trip to the East I saw a newspaper report that **John S. Hamilton** was elected to be Chairman and Chief Executive Officer of Wearever Co. Possibly the chairman of our 40th Class reunion may choose to send Jack special congratulations on this honor and a request that he supply free pots and pans to all of us who plan to attend during June, 1979. . . . **Charles Hoffman** was named Senior Vice President of system planning and interconnections at Public Service Electric and Gas Co. of Newark, N.J. . . . **Harry K. Raymond** is Manager of Marketing Services for the Benner-Newman Company in Pleasant Hill, Calif. At our 1979 reunion another good story ought to be how Harry's career led him from Course V to the design and marketing of the most complete line of public telephone booths in the industry.

Francis Recka retired after 35 years with the U.S. Government and now consults from Harwich. . . . **Francis Sargent** was appointed to the Board of Trustees of the Noble and Greenough School of Dedham, Mass. . . . **Wilbur Vincent** completed 37 years with General Electric and retired to Punta Gorda Isles, Fla., where he divides his time between boating from his own backyard canal and dock, and striving for par on a nearby golf course.

We were saddened by news of the deaths of three classmates: **Donald Bringardner** of New Smyrna Beach, Fla. There were no details; **Wendell Jacques, Sr.** of Hyannis Port. Wendell's career had been as an architect; **Frank Spooner,** of Scotch Plains, N.J. Frank's career included 35 years with Exxon Research and Engineering. Frank had been active in college teaching, Boy Scouting, and in community activities including being flute soloist in the Plainfield Symphony Orchestra. — **Hal Seykota**, Secretary, 2561 Via Viesta, La Jolla, Calif. 92037

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Naval Noise: **E.P. DiGiannantonio**, Assistant General Manager of EDO Corp.'s Washington office, is now product line manager for SONAR systems for several foreign navies as well as the U.S. Navy.

On The Move: **Wm. C. Steber** now serves as Deputy Assistant Secretary for Systems Engineering in the U.S. Dept. of Transportation.

Western Style: **Raymond E. Keyes** reports, "I am still living on the banks of the Yakima River near Richland, Wash. Virginia and I look forward to a visit this summer from fellow class and coursemate, **Alan Thewlis** and his wife, Wyn."

Golden Years: **Lloyd T. Keefe** writes, "Retired in November, 1976, after 25 years as Director of Portland, Ore., City Planning Commission and 34 years in the city planning profession. My son, Lawrence, (M.I.T. graduate 1968, aeronatics and astronautics) is now a research engineer at Wylie Laboratories in Hampton, Va." Lloyd and his wife, Gertrude, were surprised with a gift of a trip to Hawaii by grateful Portland citizens. . . . **John H. Halford, Jr.** tells us, "Three years of delightful unstructured retirement was recently broken by election to President of the Hebron Academy Board of Trustees. I was elected as a Corporator of the Museum of Science in Boston." John says he has retired in "Taxachusetts" because of friends and church and is now finishing his first new house from the inside. . . . And from **Karl L. Fetters**, "Alive, healthy, doing some consulting but not letting it be enough to interfere with travels and hobbies." Karl and his wife, Virginia,

went to Antartica and explored the Amazon river in the past year to indicate their priorities.

Golden Years, Minus One and Counting: Happy **Robert V. Gould** sends the news, "My wife and I are on our way to Holland for a pleasant year's assignment before retiring, courtesy of Sperry Systems Management. I'll be involved in the development of a new-generation vessel traffic system for the Port of Rotterdam. That's the busiest port in the world by a factor of more than two to one, and the Dutch want to keep it that way! On the home front, we've still been flying our Beech Bonzana around the country, and our son is a navy officer stationed at Patuxent River, Md."

Sad Duty: Received this month from the Alumni Association the notice of the deaths of: **Howard Carson**, February 26, 1975, in Costa Mesa, Calif.; **Robert H. Hose**, March 30, 1977, survived by his wife in Mountainside, N.J.; **Charles H. Markham**, May 6, 1977, in Merrick, N.Y., survived by his mother and his daughter. Charles retired in 1975 from L.P. Graner, Inc., New York City, then president and chairman of the board. — **Frank A. Yett**, Secretary, 254 S. Euclid Ave., Pasadena, Calif.

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Awards: **Irvin Liener** received the K. A. Spencer Award for outstanding achievement in agricultural chemistry sponsored by the Kansas City section of American Chemical Society. . . . **Saul R. Gilford**, President of Gilford Instrument Laboratories, was awarded the Distinguished Community Service Award by Oberlin College. (**Ivor Collins** attended as it was his wife Shirley's 30th Reunion at Oberlin.) Saul's company employs 600 people worldwide and in 1954 he was awarded the Commerce Department Silver Medal for "Valuable Contribution to Electronic Instrumentation in the Field of Medicine."

Directorships, Memberships: **Courtland Perkins**, President of the National Academy of Engineering was elected a member of American Academy of Arts and Sciences; **Ken Roe**, President and Chairman of the Board of Burns and Roe, Inc., to the Board of Trustees of Manhattan College; and **Lowell Fellinger** was elected a member of the A.I.Ch.E. Council.

Beaver Tales: I talked by phone with **Herb Moody** who is in Philadelphia with Rohm & Haas. Herb had a heart attack but has recovered completely. His two children are in Texas. . . . Again **Ralph Landau** is in the news. His Halcon International is constructing a $7 million research and development center in Montvale, N.J. This 75,000 sq.ft. facility will be built on a 17.4 acre site and will employ some 180 people. . . . **Frank Wyle**, Chairman of the Board of Wyle Laboratories' sent his Annual Report. The last fiscal year was the most successful in Wyle Laboratories' 27-year history. Sales were $146 million compared to $120 million the previous year. Net income was $3.7 million ($1.11/share) compared to $2 million ($0.62/share) . . . a sales gain of 22 per cent and a net income gain of 85 per cent. What will Frank do for an encore?

Losses: We had a belated notice that **Captain Morton Sunderland** died January 16, 1973. The note stated Capt. Sunderland was lost at sea while rescuing the crew of the yacht *Sunbeam* which struck an iceberg near 30°S 25°E. Our belated condolences to his family. — **Henry Avery**, Secretary, U.S.S. Chemicals, 2863 — 600 Grant St., Pittsburgh, Penn. 15230

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Thanks to **George Schwartz** and his committee for a great 35th Reunion. Attendance was 141 — classmates and spouses — and despite foul weather, a very enjoyable time was had by all. Congratulations are in order for **Jerry Coe** who retired as Class President at his request and to **George Schwartz**, our new President. You have all received Jerry's letter listing the whole slate including five new regional Vice Presidents who will be in touch with class members from time to time.

Still in the "Bouquets" Department, **Dick Meyer** has been elected to a five-year term on the M.I.T. Corporation starting last July 1. . . . **Morrie Katz** was honored as the Springfield (Mass.) B'nai Brith Youth Award.

Al VanderKloot and his wife Shirley are running Wahl-Henius Institute in Skokie, Ill. They manufacture micro-syringes for gas chromatography and do chemical testing of foods. Al's son, Robert, graduated from Course VI in June. His second son, James, is studying biochemistry at Michigan State. . . . **Henie Shaw** has a new job, organizing a central technical audit office for T.R.W.'s Defense and Space Systems Group. . . . **Bob Wilson** has sold his construction business in Columbus, Ohio, and is working at Battelle Memorial Institute there. . . . **Donn Barber**, just back from a visit to see his daughter and her family in Japan, reports that he is still at the old stand with DuPont's Financial Planning Group in the Plastics Department. . . . **Tom Hastings** checked in by means of a calling card scotch-taped to the form on his Alumni Fund Envelope. It carries four phone numbers, his address at Point Pleasant Beach in New Jersey, and Tom's affiliation with Laidlaw-Coggeshall, Inc., members of the New York Stock Exchange. If anyone is seized with a desperate need for a stockbroker while on the way to the Jersey Shore, he's the man!

Two new careers to report. **Dan Schaeffer** completed a four-year stint as a law clerk which makes him eligible to take the New York State bar examination. Dan has been a licensed patent agent for 16 years, so he will automatically become a patent attorney when he passes the bar exam. . . . In the same field, but at the other end of the land, **Carl McGinnis** has decided on a law career and started at the University of California Law Center in August.

Henry LeMaire has recently retired after ten years of teaching at the University of New Haven. . . . **David Lambert,** who retired from the Navy in 1968, is working as a technical consultant in San Diego and is ranching and sailing. Certainly sounds like an ideal program.

Just got news of the death of **Monroe R. Brown** last June in Newport News, Va. Brownie graduated in Course XVI and got his master's degree in aeronautical engineering at Stanford. He had a distinguished career in the aircraft industry, was Executive Director of the American Helicopter Manufacturers Assoc., an executive with Piesecki Helicopter Corp., and with Kollsman Instrument. Brownie was a colonel in the Air Force Reserve. He was one of our perennial bachelors and regularly attended Class Reunions. He will be remembered for his soft Virginia speech and for his quiet friendly manner. — **Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

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Professor **Wilbur B. Davenport**, of the Electrical Engineering Department at M.I.T., was elected last May to membership in the American Academy of Arts and Sciences, a national honorary society founded in 1780 by John Adams and other intellectual leaders. Its membership of 2,300 includes leading scholars, scientists, public figures and writers. . . . **Bob Rorschach**, of Tulsa, wrote, "As a consulting chemical engineer, normally engaged in the field of hydrocarbon processing, my latest endeavors are the treatment of laundry wastewater, and the formulation of a shampoo for show livestock. I wish I could hear 'Doc' Lewis' comments."

Dr. **Max G. Sherer** lectured last summer at the Hebrew University Hadassah Medical School on diabetic ketoacideris. . . . **John F. Tormey** is director of research and engineering of Rockwell's North American space operations. He has been in rocketry and now space engineering with Rockwell for over 30 years. . . . **Bill Terry, Jr.**, of Houston wrote, "I am completing 12 years as president (and now am the owner of) Tex-Fin Corp., which manufactures finned pipe for heat transfer duty. I am also president of Studco, Inc., which manufactures studded pipe for heat transfer. My son, Howard, starts at the University of Texas at Austin this fall. My wife, Sally, is still waiting for our next vacation; our last one was the 25th class reunion." You will be hearing news shortly about our 35th reunion, Bill. — **Richard M. Feingold**, Secretary, 779 Prospect Ave., West Hartford, Conn. 06105

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Another great Technology Day at M.I.T. — weather excepted! We were pleased to see friends, long time and newly found. Dorothy and **John Gardner**, Dot and **"Doc" Turner**, Marguerite and **Edgar Ahlberg**, and **Frank Carroll** were also at the luncheon. The Class of '44 sat with the Class of '43 and discovered many of the common interests that make for "small world" comments.

Reunion activities should start now for "number 35." From those of our classmates who joined in the 30th reunion in Bermuda, recommendations came to "do it again," especially from the Gardners. We translate these comments into two statements: first, another thank you to Ruth and **Norm Sebell**, who worked so hard and so successfully to make our 30th reunion such a pleasant experience; second, a call to our classmates to begin to volunteer ideas and/or themselves for our 35th. (We hereby volunteer to help on the committee, with the special hope that Ruth and **Norm Sebell** will again supply the organizing ability and elan to pull it all together.) Please don't wait for the Alumni Fund envelopes; drop us a line with your ideas and your offers to help.

A good first step would be to plan now to attend Technology Day 1978. The technical program gets better and better; this year it was excellent. A few years' back, after attending only the evening reception and hearing about all the events we had missed, we decided to set aside a vacation day in order to take in the whole day. We have never regretted it. We hope to see more of you next year in June.

An easy way to write is to use the flap on the Alumni Fund envelopes. The notes are passed on to us and become FLAP FACTS as follow: **Donald Haliburton**, who got his M.I.T degrees in Civil Engineering and in Business, is in his 20th year as chief psychiatric social worker at the Sandusky Valley Mental Health Center in Tiffin, Ohio. His service with the T.C.A. led to his interest in this work. . . . **Mortimer Meyer** writes to say he's been with Anti-Hydro Waterproofing Co. for 25 years. (He's modest; we checked the 1975 Register and he is listed as President.) His wife Jean is with the Port Authority of New York and New Jersey at Newark Airport. He adds that oldest son Bob, is a New York City attorney. Son Joey is also with the Port Authority. Son David graduated this year from Columbia. . . . **Albert Van Rennes** writes from Michigan where he is Associate Director of Bendix Research Labs. He has a wide range of activities encompassing budget and research and development planning, technological forecasting, corporate technical publications, department consultants' library, patents and international liaision. In line with his interests in planning for multidisciplinary programs he has also reorganized the lab's approach to research and developement from functional to matrix.

In addition to flap facts we get news releases. **Jack Frailey**, that awesome oarsman and Director of the Student Financial Aid Office at M.I.T., has been elected president and C.E.O. of the National Association of Amateur Oarsmen. Jack has also been appointed to the Executive Board of the U.S. Olympic Committee. He'll represent rowing, "now the third largest sport in the Olympic Games."

Some of the information we get directly from Alumni headquarters is of the inevitable but unwelcome kind. We get news of classmates who have died. We feel that their passing should be noted in these columns. **Richard L. Carter**, of the Department of Management Engineering at Rensselaer Polytechnical Institute died last year in May. He was a Course X man. . . . **Guri V. Cici**, notable in architectural design, died in April of this year. Beginning with his Navy service in the Paci-

fic during World War II, his record continues with companies like Sylvania, Dupont and with the construction company which bore his name. At the time of his death he was Assistant Professor of Architectural Design at the New York Institute of Technology. M.I.T. was notified of Professor Cici's death by Frederick R. Bentil, '50, to whom we are very grateful. . . . From a letter written to M.I.T. by his sister Sara, we learn of the death of **Richard S. Livermore** (Course V, Chemistry).

Sometimes we learn directly. We will miss the sparkle of Millie Corry, wife of our classmate **Andrew F. Corry**. Millie died August 7 after a long illness.

We noted in the last issue of *Technology Review* that 1977 graduates of M.I.T. included David F. McKinley, son of **Francis J. McKinley**; and Winifred Mary Kim Roddis, daughter of **Louis H. Roddis**, S.M. '44. Also **Michael B. Bever**, Sc.D. '44, Professor of Materials Science and Engineering at M.I.T. has retired.

Our listing of names seeking classmates has paid off doubly. **Chet Woodworth** wrote to us about **Fred De Bell** who with Hazel, his wife, has set up as the "general" of a general store in Winchester, Vt. (near Bellows Falls). Chet visited Fred on the way back from a Montreal technical meeting last April. Chet is with Monsanto Chemical Co. in Indian Orchard, which must be near East Longmeadow where he lives.

Hoping for more reunions and reports, we list more names: **Bruce T. Benepe**; **Atilio H. Cassiet** (Lt. Cmdr.); **James E. Gallivan, Jr.**; **Kimball Jencks**; **Leonidas G. Kontanis**; **Robert M. Marr, Jr.**; **Clinton F. Tillman**; **Lucien G. White**.

If anyone has, or knows of, an unwanted copy of a 1944 or 1945 (original of 10-'44) *Technique*, we would very much like it sent to us; for checking back on classmates they are very useful. Thank you. — **Melissa** and **Newton Teixeira**, Secretaries, 92 Webster Park, West Newton, Mass. 02165

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Lawrence G. Body writes from his home in Santa Ana, Calif., that he is continuing to work at the Rockwell International Space Division in Downey, Calif., with the Space Shuttle Program. The Bodys celebrated their 29th wedding anniversary in June and their daughter, Barbara, reached her fourth wedding anniversary that same month. Son Blair, just finished his senior year in architecture at the University of Florence, Italy.

Hillman Dickinson has been promoted to Major General, U.S. Army, and is now Chariman of Study on Academics and Administration at West Point. . . . **Lyal D. Asay,** M.D., is now Chief of the Department of Pediatrics, Southern California Permanente Medical Group and Kaiser Hospital, Fontana, Calif. He is also clinical Professor of Pediatrics at U.S.C. School of Medicine. . . . **Edward L. Bacon** is continuing his work with the Postal Service studying ways to save money through new technology such as electronic mail. He still manages to attend alumni affairs in the Washington area.

John L. Norton and his wife, Priscilla, continue to live in Greenville, S.C., where he is with the General Electric Co. He manages test operations at the large gas turbine plant. Their son, John, is now practicing law in Cambridge, Md., and their daughter, Linda, is teaching English at Merritt Island High School in Florida. . . . **Norbert E. Smyth** has been appointed to the new position of Manager of Salaried Personnel Relations at the Electric Boat shipyard in Groton, Conn. Previously, Norbert had been Manager of Nuclear Engineering Analysis. Norbert received his degrees from M.I.T. in naval architecture and marine engineering. . . . **Felix E. Browder** is chairman of the Department of Mathematics at the University of Chicago and director of the Student Science Training Program sponsored by his department. This summer 50 high school students from the U.S. and several foreign countries participated in an eight-week math program he arranged. "The purpose of the program," says Dr. Browder, "is to give gifted high school students a special insight into mathematics, challenging them to solve difficult problems in relatively elementary areas such as number theory."

We regret to report the death of **Alexander J. Hoffmeister** of Pittsburgh, Penn., on December 13, 1976. We have no details. Until next time, write. — **Russell K. Dostal**, Secretary, 18837 Palm Cir., Cleveland, Ohio 44126

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A highlight of our 30th reunion was the election of five Class Vice Presidents to newly-created regional positions. We expect to hear news of local class activities as they take up their responsibilities. Clockwise from home base: New England, **Don vanGreenby**; New York/New Jersey, **Dick Mooney**; Southeast, **Alex Giltinan**; West Coast, **Art Schwartz**; Midwest, **John Karmazin**. Each has a list of the classmates in his region; if you have recently moved, send me your new address, along with a little news for the Notes, and I'll send it on.

Other changes in Class Officers: **Parker Symmes** is passing the purse strings to **Hugh Flomenhoft** after 20 years of counting the cash; **Dick O'Donnell** is relinquishing the quill to **Ginny Grammer** after a ten-year stint. Our Class President, **Claude Brenner** (who else?), is now Vice President of Operations of the Northern Energy Corp., which will manage the Northeast Solar Energy Center, headquarters for solar energy development for the Northeast Region. (Only change I could think of. . .) **Jack Rizika**, Class Agent, writes of his changes: "After a magnificent year in Israel, thoroughly enjoyed by all of the family, we shall be returning to the U.S.A. for a while in the Fall of 1977. We really regret having missed our 30th and I hope Claude sent our best regards to all in attendance."

From **John Ebersberger**, as he sends some $$ along to the Alumni Fund: "Attended 30th Reunion. Everyone had wonderful time despite continuous rain. All that missed this one should plan now for 1982 (#35)." Other attendees included **Harl Aldrich** and Lois, **Bob Anderson** and Priscilla, **Robert Aquadro** and Eileen, **Bill Archibald** and Imogene, **John Bender** and Mary Jane, **Lew Bernheim** and Claire, **Bob Blount** and Jeanette, **Paul Bock** and Phoebe, **Claude Brenner** and Mary, **Dave Brown** and Sally, **Norman Brown** and Janet, **Peter Callejas** and Betty, **Dan Carnese**, **George Clifford** and guest, **Robert Connors** and Virginia, **Bob Danner** and Sally, **Steve Dieckmann** and Margaret, **Hugh Flomenhoft** and Lori, **Art Galusha** and Mary, **Warren Gillespie** and Alice, **Alex Giltinan** and Carter, **Ginny Grammer** (nee Carter), **Sid Grob** and Edna, **Marth Haas**, **Ray Hasse** and Willie, **Bob Hagopian**, **Jack Hugus** and Toni, **Fred Jenkins** and Aliss, **Martin Judge** and guest, **Ed Kane** and Jackie, **John Karmazin**, **George Katz** and Nancy, **John Kellett**, **Norman King** and Emily, **Dick Knight** and Joan, **Dave Knodel** and Pat, **Jim Kyle** and Ethel, **Mort Loewenthal**, **Bill McCurdy** and Virginia, **Tom McEvoy** and Sue, **Aaron Newman** and Florence, **Dick O'Donnell** and Gina, **Jim Phillips** and Jane, **Jim Prigoff** and Arline, **Al Richardson** and Phyl, **Lee Schwarz** and Marge, **Harry Sherman** and Rebecca, **Louis Stark** and Mary, **Parker Symmes** and Midge, **Dick Turner** and Doris, **Don vanGreenby** and guest and guest and guest (one for each event), **Arnold Varner**, **Fred Veith** and Cornelia, **Walt Weeks** and Betty, **John Yocom** and Elizabeth. Fifteen youngsters came to participate in the youth program; any bets on how many we'll have left in that age bracket in 1982?

Our clambake, which I had to miss, was moved from Georges Island (because of the weather) to the Rockwell Cage, which held Commencement earlier in the week (I didn't miss *that* clambake: received my master's degree), and, later on at the Technology Day Luncheon, the Loch Ness monster and a gigantic beaver. Ever wonder why they call it a cage?

Since there was no public announcement, it is probable that no one noticed the outgoing secretary dancing with the incoming secretary at the dinner-dance. However, it is believed to be the first time this has happened in our class.

Have you ordered your chair in 10-250 yet? Twenty-five chairs have been reserved for the Class of '47. Occupants to date are **Claude Brenner**, **Don vanGreenby**, **Harl Aldrich**, **Tom McEvoy**, and to prove distance is no deterrent, **Jack Rizika**. Remember, you can stretch your pledge over almost as many years as you originally sat there.

From **Harl Aldrich**: "I have been asked to serve as Chairman of a 'Committee on the Safety of Dams' for the Assembly of Engineering of the National Research Council. This committee will review and critique all Bureau of Reclamation activities, present and proposed, related to the safety of existing dams under their jurisdiction."

News of some who missed the Reunion: the Naval Sea Systems Command of the Navy informs us that Rear Admiral **Wayne E. Meyer**, AEGIS Project Manager, was presented the Gold Medal Award of 1976 by the American Society of Naval Engineers "in recognition of his superb leadership as a naval engineer in the development, prototype production, and successful at-sea testing of the AEGIS Combat System." He is a member of the A.S.N.E., the American Defense Preparedness Association, and the American Institute of Aeronautics and Astronautics. . . . **Jordan Baruch:** "I've taken on the job of Assistant Secretary for Science and Technology at the U.S. Department of Commerce having left my former position as Joint Professor of Engineering and Business at the Thayer School of Engineering and Tuck School of Business respectively at Dartmouth College. My address in Washington is: U.S. Department of Commerce, Room 3864, Washington, D.C. 20230. I hope that some of my old friends at Tech will find time to drop in during their visits to the Capitol."

Ed Rosenberg and Harriet write from Tehran, Iran, of a year of teaching in a private K-12 school there — two-thirds Iranian students, ten per cent American, the rest Asiatic and European. Graduates this year "have been accepted at many of the supposedly better colleges and universities in the States, starting with Harvard and going up." Ed tells of being rescued from the sands of the desert by a passing camel-herder on a motorcycle.

"We've also gone into the hills north of the city a few times. I must say I don't quite understand why they are called hills and the Berkshires mountains, but no matter. Enough hiking and camping opportunities for a lifetime, and the skiing, of difficulty about 6.5 on the open-ended Rosenberg scale (CRASH!), superb. Picture a run that starts at 3,800 meters and has a thousand-meter vertical descent, with no trees but plenty of mogols and mongols and mongrels (I was in the last category), with 18,000-foot Mt. Damavand gleaming in the apparently near distance. No clouds, no cold, no wind. Will I ever be able to start at the top of Wildcat again? From our apartment window right now I can see snow-covered ridges to our north, apartment roofs to our south, crazy traffic in the street below — it's our entertainment, and we have no need of radio of TV.

"We live in the southern, older, less fancy part of the city . . . have picked up a bit of Parsi. . . . In all, it's a distinct change from Danbury, Conn., and the only major drawback is the atmosphere, which is often about 8.7 on the closed gas-mask scale. It's better to be confined to a chemistry lab and smoke four packs a day than to draw a deep breath here."

They, like the rest of us, are looking forward to the 35th, and promised to raise a stein of the local beer in honor of Claude's rendition of the chase between the Morris and the Jag-u-ar. Write to Ed at Community School, Box 1505, Tehran, Iran, or, better still, stop by.

William Harper is the new Administrative Assistant to the President of Moran Transportation Industries, Inc., parent company of J.F. Moran Co., Moran Shipping Agencies Inc., and Moran Air Cargo Inc. He has been a Group Vice President of the Greater Providence Chamber of Commerce, involved in economic development, international trade and port development. He had

served as Executive Director of the Warwick Chamber. He is currently president of the World Trade Club of Rhode Island and secretary of the Transportation Club of Rhode Island. . . . **Ken Amer** was honored by the American Helicopter Soceity by being selected to receive the Alexander Klemin Award, presented for notable achievements in the advancement of rotary wing aeronautics. "Recently I completed my 23rd year with Hughes Helicopters in Los Angeles, the last ten years as Manager of the Technical Department. . . . Dr. Klemin, who was a professor of mine during my undergraduate days at N.Y.U., was probably at least partially responsible for my being accepted into M.I.T.'s graduate school 30 years ago. . . ."

Robert Greene is operating a consulting firm related to economic studies and planning in the oil refining, petrochemical manufacture and gas processing industries. He has four children, none married, three in college. . . . From **Charles Smith**: "Left industry in 1971 to take up own business. With wife, Mary, purchased private commercial campground "K.O.A. of Redding," Redding, Calif. Business has grown steadily. Have been active in trade association 'Kampground Owners Association.' Became Director in 1971, Secretary in 1973, and President in 1975." . . . **Sears Coker** is another dam safety man, heading up Task Group emergency Action Planning, Interagency Committee on Dam Safety. He is a Civil Engineer in the Inspections Branch, Division of Licensed Projects, Bureau of Power, Federal Power Commission, in Washington, D.C., and a member of the Working Committee of the International Niagara Board of Control and the St. Lawrence Board of Control.

Bob Devine writes: "Joined the above firm" ("above" considerately cut off by the Alumni Office) "in December 1976 to launch a new division, Robert Devine Associates, and to produce an investment strategy service for financial institutions." . . . From Sea Pines, Hilton Head Island, **Walt Kern** writes that he has bought a house there "nearer the tennis club. Keeping fit with the game and some lessons. Teradyne's expansion keeping us very busy. Daughter Jill at M.I.T. in Material Science and Ceramics." . . . **Al Steinmayer**'s youngest daughter Jan was graduated in June by Bryn Mawr magna cum laude. He is still at General Electric's Re-entry and Environmental Systems Division as manager of advanced systems programs.

News has come of the death of **John Barrett** in April and the loss of **Paul MacNeill** in February. I have sent notes of sympathy to their families, and will report anything more next month.

If you have enjoyed reading about people you haven't heard of in years, please return the favor by writing some news of *your* doings. Let others gasp in amazement, and keep my phone bills down.

I'm new in this job, and if I can't write about you, I just might write about me.

Love to all — **Ginny Grammer**, Secretary, 62 Sullivan St., Charlestown, Mass. 02129

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Ken Brock has accepted a challenging new job as Vice President for Development and Public Affairs at the Institute of International Education in New York City. Ken will be responsible for all fund raising activities. I.I.E. is the nation's oldest and largest international education organization. The organization administers scholarships and grants for more than 7,500 U.S. and foreign students each year coordinating its activities with hundreds of U.S. colleges and universities. One of the many scholarships administered by I.I.E. is the Fullbright scholarship. I.I.E. also arranges exchanges and technical assistance for international leaders, dignitaries, educators, and agencies around the world.

M.I.T. associates held a party for Ken and Ann in April, where Chancellor Paul E. Gray presented him with a Steuben design of a beaver as a tribute to Ken's dedication to M.I.T. Ken was M.I.T. Director of Resource Operations and held major responsibilities in M.I.T.'s current $225 million Leadership Campaign. The campaign announced in April, 1975, has passed the halfway mark and General James B. Lampert, M.I.T. Vice President for Resources Development, said Ken had played an essential role in the Campaign success thus far.

Ken and Ann have moved to Pleasantville, N.Y. Ken will be commuting to his offices in the United Nations Plaza.

Bob Crane wrote to me with news about another momentous change in his career. In the beginning, Bob was an electrical engineering co-op course student, working at General Radio. He received the B.S. and M.S. degrees. Bob worked at Sperry Gyroscope of Long Island on airborne radar and missile systems. In 1953 Bob joined a firm of manufacturer's representatives, and after two years, turned it around, became the president of Crane and Egert Corp. and really built a business which still runs successfully. Bob left it in 1968 to pursue what has become his main drive; medical instrumentation, and the role of engineering in the delivery of health care. Crane Bio-Medical Instruments, Inc. designed and built diagnostic instruments in cardio-pulmonary research. Four years into that and the need for additional capital was apparent. They tried to go public in 1972 — what a fiasco! So while Bob was on the unemployment roster for eight months, he took advantage of the "slow" period in his life and completed his Ph.D. thesis. Bob was graduated from Polytechnic Institute of Brooklyn with a doctorate in bioengineering. That took 11 years of night school. At our 25th Reunion Bob was out of work and rewriting his thesis, for the final time. In July, 1973 Bob became Co-Director of the Lung Transplantation Laboratory at Montefiore Hospital. In September, 1976 Bob applied to a dozen medical schools. However, no one wants old men cluttering up their classrooms, despite Bob's extensive publications (over 70) and good M.C.A.T. exam grades.

The Universidad Autonoma de Ciudad Juarez offers a program for Ph.D.'s to train for two years and to earn the M.D. degree through highly accelerated programs. Beginning this summer Bob will be living in El Paso, Tex., and taking their program for his M.D. Previous graduates who have taken the ECFMG exam (needed to be recognized in the U.S.) have done remarkably well, compared to other foreign medical school graduates. The students, all Ph.D.'s, are an older highly motivated group. It is exciting and Bob is off and running with another change in his career.

Libby, Bob's sweetheart from M.I.T. days, and Bob have been married 27 years. Their older son Randy is completing his sophomore year at U.S.C.

Kenny, their younger son, is entering his senior year in high school. Libby and Kenny will remain in their Plainview, N.Y., home while Bob is studying in Mexico. Libby and Bob have traveled to the Orient, South Africa, South America, Europe and India.

In July, I spent a Saturday nite with **Don Noble** at his home in Hingham after racing my 110 in a South Boston Y.C. regatta. Don is a manufacturer's rep. for several lines of heating and ventilating equipment which is installed in new buildings. Don has successfully adjusted his business to the cycles of the construction industry. Nancy and Don have a lovely home that is several hundred feet back from the highway. Nancy and some of the children were away at a church school at the Cape during the weekend of my visit. Their daughter Pam is a student at Yale's Divinity School.

Don recently had lunch with **Tom Scanlan** who was in Boston to discuss a new building with a public utility. Tom's company is PRESCON, manufacturers of post stressed concrete.

Ezra "Bud" Garforth, Jr. writes that he is enjoying life in the South. He owns and operates two formal-wear centers in Charlestown and Greenville, S.C. After 25 years in the metal business, it was a great change into a retail and service business. Bud likes working for himself.

In June on Thursday evening before Tech Nite at the Pops our class had a delightful cocktail party in McCormick Hall's spacious living room and courtyard. **Bob Peterson** told me of his exciting visit to Switzerland on a charter sponsored by the M.I.T. Quarter Century Club. **Russell Law** is member of the Alumni Association's Board of Directors. Jean and **Jack Juechter** are living in Jamestown, R.I., in a home with several unusual features which resulted from an architect maximizing the ease of enjoying the view of the surrounding bay. **John Walch** is still active in politics running the campaign of a candidate for governor of N.J. **Dick Harris'** company has sold textile machinery since 1831, some of which is still operating on a full-time basis. Recent laws and decisions about product liability of machinery manufacturers make Dick's company liable for these century old machines. A few of the other classmates at the cocktail party were Polly and **Nick Caldwell**, Nancy and **Don Noble**, Ann and **Ken Brock**, Tel and **Bob Sandman**, Gloria and **Sonny Monosson**, Sue Call and **Bob Bliss**, and **George Clifford**.

Sonny and I missed Rose and **Leon LaFreniere**. When Sonny called their home, no one was there to answer.

Harry F. Davis is living at 195 Albert St. Waterloo, Ontario, N21 3T4. Harry has had a minimum of contact with M.I.T. since graduation. I felt that his recent note to me suggests that Harry was proud to attend M.I.T., but 29 years of alumni status has merged into one big request for gifts to the Alumni Fund. My main reaction is that for many '48 alumni, we have added a concern for one another to our concern for M.I.T. . . . **Elliott M. Bates** wrote that he is still president of the architectural engineering firm; Allonyo J. Harriman Association in Auburn, Maine. His activities also include: Director, Y.M.C.A.; Deacon, High St. Congregational Church; Director, Friends of the Auburn Public Library; member, Maine Board of Registration of Architects. Elliott became a grandfather in 1976 and another grandchild is expected in December.

Mario S. DiQuilio is in his 12th year with the College of Continuing Education of the Rochester Institute of Technology. Mario invites visitors to Rochester to join him for a golf or tennis match. . . . **James M. Orr** writes from Chillicothe, Ohio, that he is chairman of the executive committee of Holzer Medical Center Clinic (a 37-man group practice). He is president of the northeastern region of American Group Practice Association. . . . **John Kail Crane** was appointed to the Illinois Professional Engineers Examining Committee. . . . **Ed Kratovil** has built a home in Pinehurst, N.C., to which he will be devoting his full time later this year. Thirty years of coat and tie was enough for Ed.

Bob Dean stayed at M.I.T. after graduation and earned his Sc.D. in 1954. He was Assistant Professor of Mechanical Engineering when he left in 1956 to become Head of the Advanced Engineering Department at Ingersoll-Rand Corp. In 1960 he became Director of Research at Thermal Dynamics Corp. and in 1961 he co-founded Creare, Inc. where he was president for many years. In 1976, Bob and two partners founded Creare Innovations, Inc. Bob has been a member of the Dartmouth College engineering faculty since 1961; currently he is Professor of Engineering (Adjunct). Since 1973, Bob has been the Editor of the A.S.M.E.'s *Journal of Fluids Engineering*. In 1977 he was elected to the National Academy of Engineering for his contriubtions to research and development of advanced fluid machinery.

Elias Corey has earned another distinguished award for his total synthesis of complex natural products, and his discovery of versatile synthetic reagents. Elias received an Honorary, Doctor of Science degree from Colby College. Elias is Sheldon Emery Professor at Harvard and is an organic chemist. . . . **Albert J. Kelley** will become President of a new operating unit of Arthur D. Little. The new unit will assist clients throughout the world with the management of large, complex high technology and development projects. Al had been Dean of Boston College's School of Management since 1967. — **S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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We have lots of news from Alumni Fund News Notes this month. **Alan W. Collins** writes "I'm still enjoying Ohio after escaping New York City and the two-hour twenty-minute (ugh!) commute — each way that was. I've just recently moved my department from corporate headquarters (which we donated to the City of Akron) to our largest division just south of Youngstown. Am busy and happy as Director of Management Information Services for N.R.M. Corp. I am proud to inform you that the Navy saw fit to promote me to Captain but I'm no longer flying — just staff work. I am sorry to announce that Connie and I dissolved our marriage of 23 years earlier this year." . . . **Mary C. Cretella** reports that she is also divorced hence has resumed her maiden name. She is now a senior scientist with Mobil Tyco Solar Energy Corp. in Waltham. She has been there since January, 1976, and is enjoying her work as materials scientist concerned with quality of silicon ribbon to be used for photovoltaic panels.

Robert S. Griggs writes "Readers in manufacturing companies may find of interest my article 'Operating in Puerto Rico in the Section 936 Era,' appearing in the Winter, 1977, issue of *Tax Law Review*, based on a talk I gave at a seminar sponsored by the Flagstaff Institute in Flagstaff, Arix., last August." . . . **J. S. Harford** reports "After 24 years with Niagara Blower Co., in N.Y.C., Dora and I are moving to Atlanta, Ga., to take over that office which encompasses Florida, Mississippi, Alabama, Georgia, Tennessee and S. Carolina. Our elder daughter, Andrea, will be with us — at least temporarily. Daughter Wendi is finishing as an art major at Denver University." . . . **George P. Loomis** has just moved to a new house in Chagrin Falls, and "We'll never move again!" He worked for the Educational Council this year and was amazed at the quality of today's student applicants.

James L. (Jim) Marshall writes that everyone in the immediate family has been active "in college" in one capacity or another. He is still teaching in electrical engineering at Villanova University. His wife, Maud, works in Friends Historical Library at Swarthmore College and is eprolled in the adult degree program at Goddard College. Daughter Pam recently completed her B.A. in Urban Studies at University of Michigan, and son David is a junior at Brown. . . . **Len Newton** just completed his second year as founding President of M.I.T. Club of Princeton, whose membership now numbers about 100. Recombinant DNA Symposium, visit to new AT&T corporate headquarters, M.I.T. Shakespeare Ensemble and socials involving M.I.T. area students were program highlights. Len is now an independent marketing/communications consultant in energy and electronic banking, both active fields. Ruby and Len have one son in college, two more heading there and a working daughter. The post World War II SAE-M.I.T.ers have plans afoot for a reunion later this year in which Len is also active.

O.F. (Pete) Noss, Jr. reports that he is managing the refinery for Kyungin Energy Co., Ltd. at Inchon, Korea. Bette and he have been there since March, 1976. It is a joint venture for Union Oil Co. of California and Korea Explosives Co. Bette and Pete welcome visitors. . . .

William S. Edgerly is increasingly in the news. As President and Chief Executive Officer of the State Street Bank and Trust Co. he makes speeches and issues news releases on the future of Boston in the financial world. Most recent example was his discussion on Boston as a financial capital, from the Greater Boston Chamber of Commerce Annual Report from 1976-77. . . . Finally, **David R. Israel** has been appointed Assistant Administrator for Field Operations of E.R.D.A. (the Energy Research and Development Administration). In this position, he is responsible for coordinating E.R.D.A.'s widespread field operations which include a number of laboratories, energy research centers, and field operations offices around the country.

I am writing this column in mid-August, between a two-week stint at the Program for Specialists in Organization Development which N.T.L. puts on in Bethel, Me., and a trip to North Carolina for an annual week of square dancing in Bravard. So far, the change of scene has been very energizing. I hope all of you had equally successful summers. — **Frank T. Hulswit**, Secretary, 77 Temple Rd., Concord, Mass. 01742

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John Bickford, (XV) has just been promoted to Vice President of Raymond Engineering, Inc., and Manager of its Torque Products Division. . . . *What Color Is Your Parachute?*, **Richard Bolles'** 1972 book, is a national best-seller this year — with over 500,000 copies sold. (It is sub-titled: *A Practical Manual for Job-Hunters and Career-Changers.*) A national conference on the title of his newest book (August, 1977) *The Three Boxes of Life and How to Get Out of Them*, was held in Washington, D.C., in April. . . . **George H. Dickson** (XIV) presently head of Electric System Studies Department with the Seattle office of R.W. Beck and Associates, was recently elected to the position of "Associate of the Firm" and Executive Engineer. . . . **Robert A. Pucel** (VI-A) is the co-author of an article, "Gallium Arsenide Devices for Microwave Systems," in the spring issue of *Electronics Progress.*

We regret to report the death of **John H. Anson** (VI) of Altadena, Calif., on June 19, 1977.

The Thomas L. Thurlow Award of the Institute of Navigation was presented to **Ken Fertig**, (VI), Chief Scientist at the Charles S. Draper Laboratory, during the summer; the citation is for his numerous contributions to inertial navigation and guidance technology applicable to marine, air, and space travel. As Chief Scientist at C.S.D.L., Ken is involved in early conceptualization and review of systems and basic research activities, and he serves as a consultant and member of *ad hoc* review panels for industrial and governmental organizations. He holds patents and has others pending in printed circuit resolvers, brushless motor servos, and phase-locked loop analog-digital converters.

Army Colonel **James R. Butterworth**, (XII) has been assigned to the Defense Electronics Supply Center in Dayton, Ohio, for duty as Director of Supply Operations. He comes to the Center from an assignment in Taegu, Korea, where he commanded the U.S. Inventory Management Center, while also serving as Assistant Chief of Staff for Material, 19th Support Command. Colonel Butterworth acts as principal advisor and assistant to the Center Commander in directing stock control and inventory management of over 600,000 electronic items valued at $580 million, supply support of over 21,000 activities worldwide, and development and administration of material and financial management programs. His decorations include the Bronze Star Medal, Meritorious Service Medal, Joint Service Commendation Medal, Army Commendation Medal and numerous service and campaign ribbons. The Colonel and his wife, the former Miss Lee Ki Hui, of Taegu, Korea, have one daughter: Lisa Emily.

R. Stanley Bair (IV-A) of Houston, Texas, is President-Elect of the Construction Specifications Institute. Mr. Bair is a professional member of the Houston Chapter and owner of the architectural firm of R.S. Bair Associates. He joined C.S.I. as a member of the Dallas Chapter in 1959, later serving it as President, Vice President, Director, and a member of a number of committees.In the Houston Chapter since 1967, he has served as Director and as Chairman of its Education Committee and Jury of Fellows, and in 1973 he received the C.S.I. President's Plaque. Stanley organized and taught the first specification writing course at the University of Houston. — **J. T. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

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Keep those cards and letters coming so your secretary can spread the good word about the courageous Class of 1951. **Alvin Boltax** writes that he is still working on the development of plutonium fuel and thorium fuel. Alvin believes the President's decision to defer work on plutonium is a poor one, and he hopes this position will be changed within the next two years. . . . **Amar Bose**, founder of the Bose Corp., continues his design, manufacture and marketing of loudspeakers from the facilities in Framingham, Mass. Earlier this year, Bose Corp. provided the sound system for the Montreaux Jazz Festival. Amar still finds time to lecture in electrical and electronics engineering at M.I.T. . . . **Walt Brill** of Newark, Del., has continued his outstanding tournament golf throughout the East and was awarded special honors as the only golfer ever in 54 years to shoot a double eagle on the tortuous 12th hole at Shorehaven Golf Club, East Norwalk, Conn.

Bill Cavanaugh, '51

Harold Glenzel, '51

Bill Cavanaugh has been elected president of the National Council of Acoustical Consultants, the international association of consulting firms specializing in acoustics and noise control. Bill has been involved in acoustical design worldwide and lectured in architectural acoustics at M.I.T., University of Florida, Pennsylvania State University, Rhode Island School of Design, Tulane University, and Washington University. In addition, Bill was appointed to the Massachusetts Special Commission on Noise Control Legislation, elected a fellow of the Acoustical Society of America, and a member of the Board of Examiners of the Institute of Noise Control Engineering. . . . **Roger Christman** reports he is basking in the reflected glory of his children's accomplishments. Daniel received S.B. and S.M. degrees this year in Course X, Diana is a junior in Course XV, and Eileen is a freshman in electrical engineering at Pennsylvania State University. . . . **Bob Cushman** has completed a two-year appointment, and will work two more years in nuclear safety, at the I.A.E.A. in Vienna. Bob writes that his five kinder still at home have been attending Austrian schools and speak the language just like natives. . . . **Dave Findlay** is most enthused that his son, Bruce Justin, has entered the Class of '81 at Tech.

Harold Glenzel of Hingham, Mass., has been appointed assistant vice president of buildings and real estate for New England Telephone, following several executive assignments in the N.E.T. engineering, plant construction, and buildings and real estate departments. Harold is vice president of the Hingham Rotary Club, immediate past president of the Massachusetts Building Congress, a fellow of the American Society of Civil Engineers, and past secretary of the Boston Society of Civil Engineers. Harold and his wife Lois have two children: daughter (Mrs.) Karen Adams living in San Diego, Calif., and son Steven studying at Ohio Wesleyan University.

Last June, **Fred Lehmann**, who has been associated with the M.I.T. Alumni Association since 1959, was appointed Director of Development at Boston University, the nation's fourth largest independent university. On accepting his new appointment, Fred said, "I believe it is imperative to strengthen the first rank of private universities. Independent higher education in the United States has been a fundamental instrument in bringing about the greatness that our country has achieved in a brief two centuries, and its continuity and growth are essential to our future success as a nation." Fred, his wife, and their four

children live in Boxford, Mass., where Fred is a trustee of the Town Library, and a member of the Governor's Advisory Council on Comprehensive Health Planning.

In Orlando, Fla., **Bill McClary** attended the 100th birthday party for Norman E. Seavey, M.I.T. Class of '99. . . . **Carl Schumacher** was appointed marketing research manager for Monsanto Agricultural Products Company. Carl has held several technical and marketing management positions during his 26 years with Monsanto. . . . **Clint Seeley** has been named a Fellow of the American College of Radiology and cited for his distinguished medical achievements. Clint was also elected president of the Middlesex East District Medical Society in Massachusetts, and is very active as president of the Medical staff at Melrose-Wakefield Hospital, president of L&M Radiology, Inc., senior radiologist at Lawrence General Hospital, and a managing partner of Shawsheen Radiology Associates in Andover.

George Shumway, a publisher of scholarly books in the fields of Americana and antique art, has recently published two volumes: *Rural Pennsylvania Clothing* and *Arms Makers of Maryland*. . . . **Theodore Stein** continues his busy schedule as president of Halcon Computer Technologies, Inc., a Halcon International subsidiary, responsible for computer technology relating to chemical process design and control.

Ed Stringham was elected Chairman of the Board of Trustees of Keuka College, an independent college for women in Keuka Park, N.Y. Ed is former chairman and president of Penetryn International, a worldwide marketing and engineering holding company which merged with Carborundum Corporation in 1976. Ed, an inventor and holder of several patents relating to water pollution control equipment, is active in the American Public Works Association, the American Concrete Institute, the Water Pollution Control Federation, and the Young Presidents' Organization. . . . **Donald Terp** was elected a director of the M.I.T. Club of Tampa Bay, Fla.

We are saddened to report that two classmates died this year: **Alfred R. Paashaus** and **Edward M. Stone.** Their families have our sympathy. — **Samuel Rubinovitz**, Secretary, 35 Congress St., Salem, Mass. 01970; **Paul Grady**, Assistant Secretary, 16 Brook Ln., Westport, Conn. 06880

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Arnie Kramer and his 25th Reunion committee did a fine job, despite extremely inclement weather, putting on an affair that was attended by many more class members than were expected. The rain dampened us, but did not succeed in spoiling the event. Even the clambake at Rivers Country Day School was perhaps enhanced because of the forced togetherness. We will long remember the Boston Pops with Arthur Fiedler followed by: crepes at the new Quincy Market; a stay at the New House at M.I.T. and a taste of what dormitory living has become in 25 years; and visits to many of the new facilities at M.I.T. including the Student Center and new library. Of course we will never forget the presentation of the 25th reunion class gift of $1.305 million by **Stan Sydney**, our reunion gift chairman, and **Bob Lurie**, the Beaver of the Moment. Bob's antics in his Disney-style beaver suit should bring him television notice as a professional beaver operator.

William E. Moss was unable to come for our 25th. He writes that he was sorry to have missed the event. But with his wife's 25th and his daughter's graduation from Radcliffe the following week, one trip to Cambridge was all he could manage. Bill will have three sons enrolled at M.I.T. again next year so he should be back from time to time. . . . **William S. Quigley** writes that he is presently chief of Radiology and Nuclear Medicine at Guernsey Memorial Hospital, Cambridge, Ohio. He married a woman from Ireland in 1965 and has two children, Brian (11) and Janice (10). Bill enjoys Ohio, but has made six visits back to Massachusetts in the last two years. Dr. Quigley is very active in nuclear medicine, especially nuclear cardiology. . . . Our class sailor, **Bob Danforth**, won the World's Championship of Etchells 22 Class (30-foot racing sloops) at Newport, R.I., in 1976 in competition from the U.S.A., Canada, Australia, and Bermuda.

News from the business world. Chairman, President and Chief Executive Officer of Copperweld Corp., **Phillip Hartley Smith**, notes that he recently went on the Board of Societe Imetal, a Paris-based industrial holding company. Mr. Smith was also appointed to the boards of the Telephone Co. of Pennsylvania and Pittsburgh National Bank and received an L.L.D. at Grove City College where he is also a member of the Board. He is also a member of the Board of Berea College. . . . The new Program Manager, Manufacturing Development Nuclear Division of Union Carbide is **Robert B. Burditt**. . . . **George Wu** is Product Manager, Data Base, Planning and Data Communication products of IBM. . . . **John J. McCarthy** is presently staff member in the Plasma Physics Group of the M.I.T. Research Laboratory of Electronics. John is presently involved in a project for development of an improved model of our Versator facility, a mini Alcator, for the study of plasmas.

The American Academy of Arts and Sciences on May 11 elected **Nathan Sivin** to membership. Nat is Professor of the History of Science and Chinese Culture at M.I.T.

Three deaths among our class members have been reported. **Bennie B. Mathias** of Maumee, Ohio, died August 15, 1975. Bennie was a graduate in Physics, Course VIII. . . . **John F. Belford** of Westport, Conn., died October 3, 1975. John graduated with our class in Course VI, Electrical Engineering and was Vice President of Hoffrel Instruments, Inc. . . . **Robert C. Lynch** of Danvers, Mass., died April 4, 1977. Robert was coordinator of the Science Department for the North Reading school system for the last 15 years. During the Korean War he served in the U.S. Navy for five years as a pilot holding the rank of lieutenant j.g. He was a member of the Reserves Officers Association of the U.S., Massachusetts Teachers Association, the Massachusetts Civil Air Patrol, Valladolid Council 70, Knights of Columbus, Lynn, and the New England Flyers Air Service at Beverly Airport where he also served as a flying instructor. Bob leaves his wife, Rosemarie, and two daughters, Maureen a ninth-grader in Danvers High, and Kelly a second grader in the Highland School in Danvers and a son, Robert, a seventh grader. — **Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, Mass; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, Calif.

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First, let me report that planning activity is underway with respect to our 25th Reunion (as well as the 25th Reunion gift campaigning). During late July, **Bill Spring**, **Dick Lindstrom**, **George Hegeman**, and I met to pore over preliminary details regarding the reunion — housing, banquets, parties, etc. You should receive class mailings and brochures shortly, if not sooner! Regarding the reunion gift activity, **Dick Simmons** is Chairman and, one way or another, will be in touch with each of you. (**Betty Ann Lehmann** and **Nelson Lees** joined us in a later meeting on this score.) Hopefully, you millionaires will come out of the woodwork and help make up for the less ample gifts of not-so-successful classmates. As a reminder, let me point out that *pledges* for five years *in the future* will all be counted in the 25th reunion gift total to be reported next June. And rather than "dun" any of you, let me simply ask that each of you *please* give what you can, in cash or pledge.

Among the notes accompanying Alumni Fund gifts were the following items: **Stuart Solomon** is President of Richmond (Va.) Pediatrics, Inc.; his son is a junior pre-med at Harvard, while his daughter is a high school senior. His wife (Roberta) is active as President of the Medical College of Virginia Faculty Wives. . . . **William Lintner** reports that he is Vice President and Principal of L and L Chemical Construction and Engineering Co., a firm which designs and constructs chemical manufacturing plants in the New Jersey area. . . . **Alvan Lampke** is self-employed in a building and construction company; he just recently passed the N.C.A.R.B. exam for registration in Connecticut. . . . **John Miller** is President of Intermetrics, Inc., Cambridge. . . . **Alexander Pasztor** sent in a more chatty note: "After 17 years in radar and digital computers, mostly in marketing, technical, and management capacities, I got into RV manufacturing. Two years of that convinced me to stay out of manufacturing, and I have been in sales ever since, selling big and little motor homes, sending many happy wanderers on their way to faraway places. Am considering going back into electronic sales, now that microcomputers are on the scene at consumer prices." . . . And in Brussels, **Jack Walsh** continues as President, York Europe Division, Borg Warner Corp. Of four children, a son is attending the University of London and a daughter is at Syracuse; and Jack continues to enjoy cross-country horseback riding and skiing.

Other news: **Bruce Murray** co-authored a recent book, *Flight to Mercury,* which documents the flight of Mariner 10, the automated spacecraft launched in November, 1973, to obtain the first photographs of the planet Mercury. . . . In a recent news release, the New York Chapter of the American Institute of Architects announced that **Stephen Kliment** was elected Secretary for the forthcoming year. . . . **Bill Gouse** continues to dole out (rather generously — to some, but thus far none to me) zillions of dollars as Deputy Administrator of Fossil Energy for E.R.D.A.; to date, I have no report on his job tenure following organization of the new Energy Department. . . . The latest annual report of the Greater Boston Chamber of Commerce called upon ten of its committee members to comment upon Greater Boston, what it has to offer, and the Chamber's role in shaping its image. Among the ten was **John Ehrenfeld** who, in particular, viewed environmental matters. John is presently Vice President and Technical Director of Energy Resources Co. and a visiting lecturer in the M.I.T. Chemical Engineering Department.

The Secretary of the Class of 1976 did us a service by "interviewing" **Carl Swanson** — with whom he had dinner at Durgin-Park. His report: "Carl has four children, three girls and a boy, two of which are in college — a daughter at R.P.I. and a son at Northeastern. He lives in Boylston, Mass., a suburb of Springfield, and feels that country life is 'fantastic.' He is working for Fenwald, a job of 10 years standing." (My thanks to Arthur Carp for passing the news along.) . . . Apparently, **Jim Mast** felt sufficiently remorseful (about my lack of news) to bug his wife into writing. (Others of you *can* follow suit!) Martha notes, "Jim's very busy — still building custom houses — and also serves as Mayor Pro Tem of Grosse Pointe Farms. This is his second four-year term on the Council. Earlier this month he was elected to the Board of the Childrens' Home of Detroit." She also reported that their interest in Meso-American archaeology continues (an interest, I might add, which they generously shared with me when I was living in Detroit), heightened by trips to Guatemala and the Yucatan in recent years.

As you know, it is my inclination to take the view that "*All* news is fit to print, even if true." Bear in mind, though, that if I libel you, it will be done without malice. At any rate, please take pen in hand. — **Martin Wohl,** Secretary, 7520 Carriage Ln., Pittsburgh, Penn., 15221

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Hope that you all had a nice summer. **Hugh Nutley** received an M.S. in chemical engineering from the University of Washington and has filed a patent application on a theory that he suggested in his thesis. How about disclosing at least the general subject to us, Hugh? . . . **Ezra Ehrenkrantz** has received yet another honor, this time from the Building Research Advisory Board of the National Academy of Sciences-National Academy

of Engineering-National Research Council (doesn't that have a short title?) for contributions in the building industry.

Ted Slosek is manager of marketing for General Electric's Vallecitos Nuclear Center (radioactive materials for nuclear diagnostic medicine). Ted was delighted with recent visits by "easterners" **Bard Crawford** and **George Thurlow**. . . . **Philip Sayre** now heads up the Sprague Meter Division of Textron in Bridgeport, Conn. Phil has been a U.S. Air Force command pilot, a Sloan Fellow at M.I.T., and attended special courses at Harvard Law School and Harvard Business School.

Dave Wiesen hasn't sat still for the last six months. In January he visited San Diego, Palm Springs, and Los Angeles on business and saw Hal Shapiro, '51, while there. Then business took him to Israel where he met with **Harry Taylor**. Finally, for relaxation, he toured England, Scotland, and Wales (2,000 miles in two weeks) with his wife Muriel and son Sloan (8). They visited such places as Newark on Trent, (Muriel is setting up an "International Association of Newarks"), Carlisle, Scotland, and Loch Ness where they met Dennis Meredith, Dr. Rines, and Dr. Milne, the archaeologist looking into the underwater stone rings. . . . Peggy and **Dave Howes** also spent a delightful two weeks in England during June, mostly in Kent County sampling pub fare and touring the picturesque contryside. — **Dave Howes**, Secretary, Box 66, Carlisle, Mass. 01741; Assistant Secretaries: **Chuck Masison**, 76 Spellman Rd., Westwood, Mass. 02190; and **Lou Mahoney**, 6 Danby Rd., Stoneham, Mass. 02180

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Among the rewards of being class secretary (chauffered limousine, free vacations, Locke-Ober meal ticket) are occasional letters from classmates. And I do mean occasional. But the following (somewhat edited) surprised me in coming, and I thought you'd enjoy it as I did: "Dear Mr. Schell: While working at *The Tech* (as I consistently do) I have noticed that my father never appears in the class notes of his year (*The Tech* does the production work for *Tech Review* class notes, which is how I noticed.) Since I suspect that my father has never contributed any news of himself, I decided to do so for him.

"**Lawrence Joel Berman** is alive and well and living in Cambridge. At some point during his busy college years at the 'Tute (he took a combined B.S.-M.S. program in Aero-Astro, from which he got his two degrees in '56, ran cross-country, wrestled, and sang), he managed to marry Sara Mae Sidore (Rhode Island School of Design, '58). After his graduation he had various research assistant-type jobs at M.I.T., commuting to Cambridge from their apartment in Providence, until Sara Mae graduated, already several months pregnant with their first child.

"In July of 1958 Larry and Sara Mae bought an enormous half-house near Inman Sq. in Cambridge (it has the biggest yard east of Hahvahd Sq.) and in August they had me, Pandora Beth. They named me after her parents' sweater factory and her grandmother, in that order.

"During the ensuing few years Larry and Sara Mae began the still-continuing renovation of our house and had Alexander (after Larry's father) in '59 and Jonathan (after no one in particular) in '63. Larry joined the Instrumentation Lab, and introduced Sara Mae to distance running, which he had taken up as an end in itself (an extension of his high school and college cross-country) after a knee injury in college ended his wrestling career. Together with a few friends from the Lab, Larry and Sara Mae formed the Metropolitan Athletic Club (later renamed the Cambridge Sports Union) to fill the existing need of a running club for whole families in eastern Mass. They sent their children (somewhat to the horror of their local young, college-educated friends) to Cambridge public schools. Sara Mae became (was appointed, I think) Chairman of the Women's Track and Field (it wasn't long distance yet) Committee for the eastern division of the A.A.U. By her continued high-quality running over these many years, as well as her efforts to organize and train other women, and her politicking in running circles, she helped force the A.A.U. to increase its maximum distance for women's races from 880 yds. in 1960.

"In the middle of all this, Larry was busily programming away at the Instrumentation Lab, working on the Apollo guidance program. When Apollo 14 went up and the docking ring stuck to the LEM after it seperated from the Command Module, Larry's group spent a couple long nights programming and sent out the word that it didn't matter (they were right). Over the past two years his group has been doing the independent verification of the flight code for the Defense Meteorological Satellite; they essentially saved it from oblivion by reprogramming it to work without its dead gyroscopes.

"Larry, in his spare time, worked out a computerized scoring system for ski races. At first it was used only in the eastern section of the U.S.A., but it was eventually adopted as the national system, and is now used to pick national teams.

"Penny, (that's me), after spending grades K-9 in Cambridge schools, followed her father's footsteps first to Phillips Exeter Academy for her last three years of high school, where she mostly ran and studied, and then to M.I.T. There, 25 years behind her father, she is busily engaged in Course 26 (Hacking and other Activities) — she is a brother and next semester's Newsletter Editor in Alpha Chi (the M.I.T.) chapter of Alpha Phi Omega, the National Service Fraternity, one of four Night Editors at *The Tech*, and a coolie on the Projection and Refreshments Committees of L.S.C. Despite these time sinks and her friends at ESP, M.I.T. Science Fiction Society, and even *Technique*, she has managed to pass all her courses this year. However, she is not continuing her past three summers' job at Draper this summer; (I've decided I need a summer off to rest and learn to drive, and keep hacking).

"Sandy (Alexander) after his many years in Cambridge public schools, intermingled with a few at the (private) Cambridge Friends School, has just graduated from Rindge Technical School and is looking forward to W.P.I. in the fall. He has also progressed from newspaper delivering to house renovation for fun and profit (for his aunt and his parents).

"Jonathan is about to graduate from the Cambridge Alternative Public School; he will enter the Combined Cambridge High School in September.

"Sara Mae was a candidate for Cambridge School Committee in 1975. She won then and is now making her bid for re-election.

"Oh, and also — Larry and Sara Mae still love each other. Sincerely, Pandora Berman, M.I.T. '80." — Class secretaries: **Allan C. Schell**, 19 Wedgemere Ave., Winchester, Mass. 01890; **Marc S. Gross**, 3 Franklin Court, Ardsley, N.Y.

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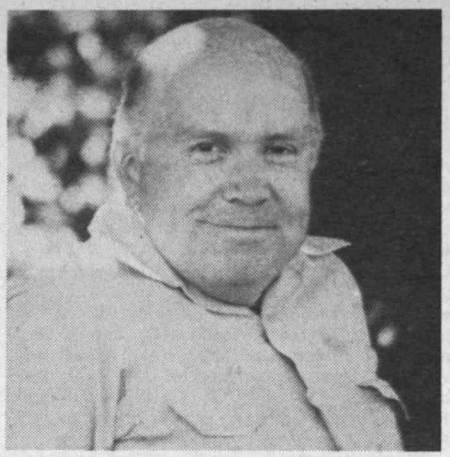
Ben Lightfoot keeps in touch with several classmates in southern Calif., through an annual gathering of the Course XVI grads — including Professor **Fred Culick** of Cal Tech., **Gerry Sozio** and **David Mitchell** of TRW, **Haig Parechanian** of McDonnell Douglas, and **Charley Hoult**. Ben reports that **Phil Battaglia** is one of Douglas Aircraft's top test pilots and lives in Mission Viejo, and also that **Dick Teper** is with Rocketdyne and lives in Granada Hills. Ben is Vice President of Engineering at Continental Airlines, located at the L.A. Airport. So, we know whom to call the next time we're awaiting "mechanical difficulties" if that airline has such.

Charley Dietrich has been with Bolt, Beranek and Newman in Cambridge, Mass., since graduation with his S.M. in electrical engineering. He heads their Regulatory Acoustics Consulting Group, and has become a world authority on the legal and technical problems of noise control. Charlie has drafted several state and federal laws on noise regulation, starting with the first noise code implemented by Chicago in 1970. His group has designed several "noise traps" for the



Charles Dietrich, '56, does his part to quiet the highways and cities of the U.S. as head of the Regulatory Acoustics Group at Bolt, Beranek and Newman.

Interstate Highway System, so please beware. Charlie and Marylin were married in 1963, and have one child.

Karl Pearsons is also with Bolt, Beranek, and Newman, as Manager of their Psycho Acoustics Department in Canoga Park, Calif. He and Kitty have four children. . . . Dr. **John Sirmalis** was promoted to Head of the Weapons Systems Department at the Naval Underwater System Center in Newport, R.I. He joined the Lab in 1957, following his S.M. in Mechanical Engineering at Tech, and completed his Ph.D. at University of Rhode Island in 1975. He had been Program Manager of the MK-30 Sub Simulator, and Chief of the Advanced Weapons Division at the Center. John and Elaine live with their four children in Barrington, R.I. — Co-secretarues: **Bruce Bredehoft**, 7100 Lanham Dr., Edina, Minn. 35435 (Tel: 612-941-7438); **Warren G. Briggs**, Northeastern University, Deree College, Box 472, Athens, Greece, (September 77-July 78).

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Well, at the Reunion I was elected Secretary for another five-year term. So you've stuck with it, and here goes. . .

First, the Reunion was a great success. From comments I've picked up, having the Reunion on campus was liked by most people. It tended to keep everyone together and allowed everyone to see how much everything at Tech has changed. Those who brought their children found them happily and fully occupied. The poor weather cancelled the clambake, but there was a fun dinner at the Historical Collections gallery and stimulating Technology Day lectures. Next month I'll try and include a full report on the class questionnaire. A preview: it depicts a rather sober group!

At the last minute I had to miss the Reunion. The day before the Reunion I started a new job and a new career, and I was tied up until very late on the Friday night of the Reunion weekend. I've left the oil business after 19 years and joined the City of New York; I'm now Senior Vice President of Finance for the New York City Health and Hospitals Corporation, the public benefit corporation that runs the city's 17 municipal hospitals. It's the largest hospital system in the United States with a budget of over $1 billion and some 35,000 employees. With a myriad of financial and management problems, it will be very stimulating work. I'm happy to be actively involved with the City government; among other things it means we'll remain in Manhattan, which we love. If you're in the Big Apple drop by and see me. My office is at 125 Worth Street (near City Hall). My new telephone number is 566-8060.

Now for the rest of the news. From **Mel Gins-**

burg: "My current title is Staff Geophysicist. I am still with Mobil Oil Corporation in Dallas, Texas, Exploration Services Center, Mobil Exploration and Producing Services, Incorporated." . . . **Charles Morrison** is now General Manager of Vac-Tec Systems, which develops and builds thin film coating equipment." . . . And **Charles Lingle, Jr.** also has a new job. He is Engineering Manager for Swedlow, Inc., in Garden Grove, California.

That's all for this month. Please send news or it will be a tough five years! Personal for A.R. in Philadelphia: Thanks for the "encouragement". — **Frederick L. Morefield**, Secretary, 285 Riverside Dr., New York, N.Y. 10025

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A very encouraging mail bag the last few months as the backs of Alumni Fund envelopes had messages from many in the class. Annual greetings from **Bob Polutchko** in Denver who has been appointed Technical Director for Special Programs at Martin Marietta and who also received the N.A.S.A. Public Service Medal for his efforts on the successful Viking missions to Mars. . . . **George Elbaum**, who ties up the airspace traveling between Los Angeles and Moscow, maintains his active schedule representing instrumentation and other manufacturers. . . . **Steve Denker**, Our man in New York, sends regards from the oldest established Alumni Center. When classmates are traveling in the New York area, they should stop by the M.I.T. Center, located in the Chemist's Club building at 50 E. 41st St., and visit with Steve who represents the Alumni Association in the area. . . . Colonel **George Connor** reports from his new assignment as division chemical officer of the 1st Armored Division in Ansbach, Germany. . . . Regards also received from **David Pawliger**, M.D., who went from civil engineering to medicine and now practices internal medicine, hematology and oncology in Florida, where he also serves as Assistant Professor of Medicine at the University of Florida in Gainesville.

Recent appointments and honors to **Lawrence Roberts**, appointed to the Electrical Engineering Visiting Committee at M.I.T.; **Walter Humann**, elected a director of First Texas Financial Corp., a Dallas savings and loan holding company; **Charles Spangler**, appointed chairperson of the chemistry department of Northern Illinois University; and **John van Raalte**, elected a Fellow of the Society for Information Display.

More detailed histories and notes: class veep, **Bob McAuliffe** left Philadelphia in 1974, becoming a neighbor in Newton and starting his own firm in the area of industrial and residential land planning and engineering. Bob recently attended his tenth reunion at a business school up river. He still maintains his instrument, commercial and flight instructor ratings. . . . **Jack Fischer** relocated in 1975 from Philadelphia (wonder what led to the exodus of '59ers) to Peabody, Mass., where he serves as Treasurer and Chief Financial Officer of Walbar, a manufacturer of jet and gas turbine engine components.

That's it for now. Keep those cards and letters coming to **Phil Richardson**, 180 Riverside Dr., New York, N.Y. 10024; **John Amrein**, 770 Greenwood Ave., Glencoe, Ill. 60022; **Adul Pinsuvana**, A.S.E.A.N. Secretariat, 6 Jalan Taman Pejambon, Jakarta, Indonesia; **Bob Muh**, 907 Chantilly Rd., Los Angeles, Calif. 90024; or **Allan Bufferd**, 8 Whitney Rd., Newtonville, Mass. 02160

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My family and I are in the midst of unpacking after a major move, but I have been able to unearth the class notes materials, hopefully in time to make the *TR* deadline. Now if I can fine the typewriter, I am all set. Here it is, sandwiched between the book carton which we did not open after the last move and my valuable collection of Project Apollo beer mugs.

The first item, written on the back of an alumni fund envelope, begins, "One son, Andrew, age 8

Henry Piehler, '60

— very bright, promoted to Associate Professor of Physics with tenure, Rice University, July, 1977." Now I have heard of bright children, but I think that **Gordon Mutchler**'s son must have set a record. Gordon also reports that his wife, Lynn, Class of 1961, is working as a computer programmer at the University of Texas Medical Center.

Henry Piehler, Professor of Metallurgy and Materials Science at Carnegie-Mellon University, has been elected a director of the American Society for Testing and Materials. Henry has been with Carnegie-Mellon for the past ten years, and since 1972, he has been an adjunct professor of law at Duquesne University as well. He is an associate editor of *Metallurgical Transactions* and a member of several A.S.T.M. committees, including forensic sciences, medical and surgical materials and devices, and technical aspects of products liability litigation. Henry also is a member of the American Institute of Mining, Metallurgical and Petroleum Engineers, American Society for Metals, American Association for the Advancement of Science, American Powder Metallurgy Institute, Standards Engineers Society, Sigma Gamma Tau, and Sigma Xi.

Sanford Miller has spent another summer at Babes-Bolyai University in Cluj-Napoca, Romania, with his wife and two children. Sanford, a mathematics professor at the State University College at Brockport (N.Y.), was awarded a National Academy of Sciences research exchange grant for the trip, and he will lecture on complex-function and univalent-function theory while in Romania.

After graduating from M.I.T. in Course XVIII, **Jerome Sashin** attended the N.Y.U. School of Medicine, interning at the University of Utah and returning to Boston for psychiatric residency at the Massachusetts Mental Health Center. He spent two years as a research fellow at B.U. Medical School, and in 1974, he joined the Tufts School of Medicine, where he is currently Associate Clinical Professor of Psychiatry. Jerome completed training at the Boston Psychoanalytic Society Institute in 1974 and is on the faculty of the Psychoanalytic Institute of New England-East. He is board-certified and an active member of the American Psychoanalytic Association. On the personal side, Jerome married Bonnie in 1972, and their first child, Daphne, was born in 1976.

Richard Bertman has been appointed to the Massachusetts Board of Registration of Architects. Richard is with the Boston firm of Childs, Bertman, Tseckares Associates, Inc. He has been an assistant professor at the Rhode Island School of Design, has conducted a conference on religious architecture, and has been a visiting architectural critic at several universities. He is Vice President of the Boston Architectural Center and a member of the Building Officials Conference of America, the Urban Land Institute, the Society for Preservation of New England Antiquities, and the Boston Society of Architects. Richard, Sandra, and their three children live in Newton Centre.

David Rod, Professor of Mathematics at the University of Calgary, was an invited speaker at the International Mathematics Conference in Como, Italy. . . . **William Nicholson** and his wife became the parents of their third child and second daughter, Kay Seaman, in November, 1976.

A number of our classmates have dropped from the rolls of active alumni, and over the next several months I will publish their last names in alphabetical order. Here is the first batch: **Alkoff, Altman, Anderson, Arditti, Arzoumanian, Autenreith, Babaoff, Badger, Barton, Bearman, Bolz, Brown, Campbell, Cha, Chadwick, Chute, Denison, Dill, Dini, Donaldson, Drucker**, and **DuBois**. If your name is on the list or if you know the whereabouts of any of these people, please send me or the Alumni Association a current address.

And speaking of addresses, I have an address change of my own. After four years as a member of the technical staff of The Analytic Sciences Corp., **Robert Stengel** has joined the faculty of Princeton University as Associate Professor of Aerospace and Mechanical Sciences and director of the Flight Research Laboratory. I will be teaching aircraft dynamics, estimation, and control, as well as conducting research in atmospheric flight mechanics, aircraft handling qualities, and human factors. One of my first projects is a flight simulation of the Space Shuttle using one of Princeton's variable-stability Navions. To complete the picture, I am an associate fellow of the American Institute of Aeronautics and Astronautics, a member of the Institute of Electrical and Electronics Engineers, and author of over two dozen papers. My wife, Pegi, our children, Brooke (8) and Christopher (1), and I welcome you to visit if you are in our area, and I would be happy to give interested parties a "Cook's Tour" of the experimental facilities at F.R.L., including our powered aircraft, ground-effect machines, sailplanes, experimental automobiles, and a visiting manned ornithopter. — **Robert F. Stengel**, Secretary, 329 Prospect Ave., Princeton, N. J. 08540

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Another year has rolled by. I guess that as we grow older each individual year seems less important in the scheme of things. The coming year is certain to pass as quickly as the previous one, and that will bring us to our 15-year reunion. Hard to believe. . . . Though no plans for that reunion have been announced as of this writing (August) you might make a note on your calender and save some time for vacation in the early part of June, 1978. New England is beautiful at that time of year. Let's have a record turn-out for this reunion. I'll put details in this column as they become available. And now, on with the news.

Tony Dralle works for Westinghouse Electric at the Bettis Atomic Power Laboratory. He is responsible for the neutron cross section programs used in reactor design and analysis. Tony, his wife, and their son live in Bethel Park, Penn., and Tony dabbles in gardening and amateur astronomy. . . . **Cal Yee** reports that he has a new job as business Systems Manager with Federated Department Stores in Cincinnati. . . . Class President **Garry Stone** is currently doing analysis of venture capital proposals in the electronics field for Exxon Enterprises, Inc. This is the new business development group at Exxon. . . . **Robert Dinsmore** is continuing his activities as architectural project manager for the Portland, Ore., Office of Skidmore, Owings & Merrill. He is completing the final year of a new research laboratory building for the Weyerhaeuser Co. in Tacoma, Wash.

Dr. **John Flaherty** is in his third year (actually, by the time this appears in print it will probably be your fourth year) as an assistant professor at the Johns Hopkins School of Medicine. He spends 80 per cent of his time in research activities, studying the pathophysiology of myocardial ischemia. (Hope I spelled that right!) . . . **Elliot Bird** writes that he spent his sabbatical year (1975-76) in the N.S.F.-sponsored mathematical scholars training program administered by Washington State University in Pullman. His first and last months were spent in Pullman with classes in math education from morning until night. In between, Elliot, his wife Toby, and their son Eric lived in Seattle where Elliot had nine-week experiences teaching mathematics at every grade level from

kindergarten through 12. The result of this program was an M.Ed. degree from W.S.U. The Birds took advantage of their trip to do a lot of sight-seeing. They camped their way back and forth across the country, and into Alaska and Canada.

A note from **Dave Juncker** contained the information that Dave had just completed a year with Medtronic, Inc. (the pacemaker people) and had the luck to be promoted from supercoolie in the Regulatory Affairs Dept. to Director of Leads Development. Leads, the note goes on, are the interconnectors from the pacemakers to the patient's heart. Dave is still resisting wearing ties. For a tenth anniversary celebration he and his wife, Trudi, spent a week in Puerto Rico. Dave reports that **Gary Palonen** is alive and well in Washington, D.C., as Vice President and Technical Director of VEDA, Inc. Gary has fallen in love with the Washington area. Dave says he has come to believe that D.C. might actually be Minneapolis — South. Such regional chauvinism!

Some news from a classmate who is almost a neighbor of mine reveal that **Peter Mlynaryk** has been at California State University at Fullerton since 1967. As a result of a recent promotion Peter assumes the position of Chair, Department of Finance, at the start of the 1977-78 academic year.

William Zoller, President of William C. Zoller and Associates, Architects, Planners, P.A. of Bradenton, Fla., is currently working on a $200-million project in the Tampa Bay area. . . . **Alan Schindler** recived his M.D. degree from the University of Pennsylvania last May. . . . **Tom Gerrity** was the subject of a spring, 1977, Sloan School Newsletter article. The story focused on Tom's work as a founder of Index Systems, a consulting company which applies computer technology to business problems.

Enough news for the present. More next month. Drop me a line if you're feeling ambitious. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, Calif. 92115

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Greetings '64! Here it is only the middle of August and the summer seems long gone (even in Washington!) I guess that must be the disadvantage of taking one's vacation early. We had our two weeks in Ogunquit (Maine) the last week in June and the first week in July. It was great, kids, friends relatives and all. Celebrated our 11th along the way. Whew, how the time does fly.

Received a nice note from **Ron Gilman** earlier in the summer. It wasn't any special new news that motivated Ron to write, just ten years of first-hand class secretary experience which had taught him well the woes of the "summer mail drought." So, class hero status to you, Ron, and thanks for the note. All you would-be-class-heros, take note; better yet, take pen in hand and scribble down a thought or two.

Now on to the last cluster of 1976-77 Alumni Fund Challenge contribution envelopes, and *thank you again:* Newly relocated to Naperville, Ill., are **Tom Arnold** and his wife Carol and their two sons. Tom is head of a department involved in processor development at the Bell Lab location in Naperville. . . . **Leo Cardillo** is coming up on 13 years as a civilian employee in the Dept. of the Army Communications Engineering covering frequencies from DC to daylight. The family includes three children, Laura, Frank and now Eileen, born this past June 4. . . . A brown belt in karate has recently been earned by **A. Robert Chinchillo**.

John B. Eulenbert is Associate Professor of Computer Science and Linguistics at Michigan State University where he is also director of the Artifical Language Laboratory working on computer-based aids for people with communication handicaps. . . . **John Prosek, Jr.** is still employed with Turner Construction Co., but is being transferred to the San Francisco office. He, his wife Beverly and daughter Amy, are looking forward to the relocation, having spent most of their lives in the central states. . . . For the next four years **Marcia Root** will be juggling college and family life to achieve her goal of Master of Divinity from Andover-Newton Theological School (Newton, Mass.). Her husband Stephen ('62) and three children will be helping with the housework for awhile, and the Cub Scouts, League of Women Voters, etc. are also going to miss her. . . . **Patricia Page Wilcox** and John Wilcox were married on February 5, 1977. They are living in the country with two kids, a big garden, and a large assembly of antique gas engines. Patricia is also keeping busy fixing up an old house, surveying caves in Kentucky and making maps for the county.

That's it for envelopes. It's been pretty sparse. If we have no news, you get no column, and M.I.T. needs the alumni to help — so keep those envelopes coming. Another bit of news came by way of a newspaper clipping. **Stephen Kraysler** has been appointed a full-time actuary for Hanseco Insurance Co., a subsidiary of John Hancock Mutual Life Insurance Co. Stephen has been associated with the subsidiary since its inception in 1972 and was elected vice president, actuarial in April, 1976. In his new post, he will have complete responsibility for all actuarial functions including financial projections, forecasts of capital requirements, studies of new insurance times and coordination with affiliate Sutry Insurance of Wisconsin. The Krayslers live in Norwell, Mass., with their daughters. Stephen is a member of the Norwell Advisory Board and former member of the Norwell Capital Budget Committee as well as being a fellow of the Society of Actuaries and a member of the American Academy of Actuaries.

Back to the local scene (Washington, that is), summer has been ghastly — a hot, muggy day after day that only PEPCO and VEPCO could love (those are the electric power companies that keep all the centrally air-conditioned homes cool). This was only our second summer here, but this one lived up to the local reputation for the area; last summer seemed quite pleasant, as best I can recall. I hope your summer was a pleasant one. Please write. — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, Md. 20854

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The long summer hiatus has allowed lots of news to accumulate from Alumni Fund envelopes, but this column will exhaust them — so write! **John (J.D.) Roach**, a former Wellesley neighbor, writes to say that he is active as Vice President of the Boston Consulting Group in Menlo Park, Calif. John and Pam and daughters (Vanessa, 7, and Alexandra, 5,) live two blocks from Barry Roach, '62. John is enjoying running, swimming and bicycling; having completed 3 marathons, he hopes to run in the Boston Marathon next year.

Dennis Slevin is at the University of Pittsburgh as Associate Professor of Business Administration and Director of Executive Development. . . . Ellen and **Rob Silverstein** and children Seth, Rachel and Alison, have been in the D.C. area for seven years. After three and a half years on the staff of the Director of the C.I.A., Rob returned to private industry to open a center for defense and foreign policy analysis for Northrop Corp. . . . **Bob Roper** is now with Data Resources, Inc., in Lexington, Mass.

Jeffrey Meldman is Assistant Professor of Management Science at Sloan, and is also on the part-time faculties of Boston College Law School and the Franklin Pierce Law Center. **David Cook** practices internal medicine and oncology and was recently appointed Assistant Clinical Professor of Medicine at Michigan State University. . . . **Bill Brody** is finishing his residency in radiology and will return to Stanford as Associate Professor of Radiology and Electrical Engineering. . . . **Paul Kasameyer** is now on the West Coast working in the geothermal program at Lawrence Livermore Laboratory; the Kasameyers have three children: Karen (7), Amy (4) and Alan (2).

Homa Lee is working in marine geotechnology research with the Navy's civil engineering lab at Port Hueneme, Calif. . . . Another Californian is **John Butler**, who is working for C.F. Braun in Alhambra and recently bought a house in Pasadena. John is working on coal gasification (trying to keep us all from freezing in the dark). . . . Further north is **Warren Anderson**, who is practicing neurology in Portland; the Andersons have two children, Elise (3) and Shannon (1).

The **Joseph Dyro**'s had their first child, Carolyn, last June. Carolyn served as a test subject for Daddy, who was completing tests of infant incubators and radiant warmers. His job as program manager of educational services at the Emergency Care Research Institute has taken him from Holland to Hawaii to lecture on safety hazards of medical equipment. . . . **Dennis Bekeny** passed on the news that Emily and **Gene Chase** had their first child, a son, recently. . . . News clippings tell us that **Steve Lipner**, our former Class Secretary, has been promoted to Associate Department Head and Site Leader.

I must pass on the news of the death last August of **John Memley**. — **Edward P. Hoffer**, M.D., Secretary, 12 Upland Rd., Wellesley, Mass. 02181

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There is a fair amount of mail. However, first some news about myself. In mid-July I left Citibank and joined Arlen Realty & Development Corp. as Executive Vice President and Chief Financial Officer. Arlen is a diversified developer, owner and manager of real estate (shopping centers, apartments and office buildings), and is the largest publicly held real estate company in the country. In addition, Arlen owns 100 per cent of Korvettes Department Stores with sales of about $650 million a year. Thus far, the job is a lot of fun and is keeping me very busy. I would guess that it will end up costing me a couple of strokes in my golf handicap.

Dimitri Procos updates us for the first time saying that after he obtained his M.Arch. from Pratt in 1967 he worked for two years in a planning office in Toronto. In 1969 he joined the faculty of Architecture at Nova Scotia Technical College in Halifax, Canada. In 1976 he published his first book, *Mixed Land Use; From Revival to Innovation*, which was listed by the Library of Urban Affairs in the summer of 1976 and again in May, 1977. He is currently writing another book (in collaboration) on the application of human activity data to the planning of the urban environment. . . . **Robert Silver** was transferred to DuPont's Photo Products Dept. in Parlin, N.J., and lives in Marlboro, N.J., where he enjoys being near the N.Y.C. metro area. . . . **Robert Marsh, Jr.** is now with Courier Terminal Systems in Tempe, Ariz., and presiding over the M.I.T. Club of Arizona.

Marty McGowan and family arrived in Colorado in December, 1975, and continues as Senior Software Engineer for Ford Aerospace, writing maneuver analysis software for NORAD's Space Computation Center. He and Patty are active in adult education. Patty teaches Computer Science at U.C.C.S. Marty ran into **Ken Browning** on a trip west last fall. During this past July, **Richard Brady** taught math to junior high school students at St. Mary's College Center for the Gifted and Talented. He is back teaching at Sidwell Friends this fall.

Joseph Bravman was promoted to Director, Electronic Programs at Fairchild Space and Electronics Co., and is building a new deck home. . . . **Mark Yogman** in Novermber, 1976, became General Manager for Thermoplastic Urethane Elastomer at Mobay Chemical after serving two years as Manager in Corporate Planning. . . . **Gerry Lichtenberger** moved to larger quarters to accomodate his co-founded two-year-old company, Xybion Corp., which now staffs 25. Son, Jason, is about 1 year old.

Peter Cukor updates us saying he received his Ph.D. in chemical engineering from U.C., Berkeley in 1971, was a postdoctoral fellow at Harvard University and Harvard Business School, married Andrea Healy in 1972, in 1973 joined Teknekron, Inc., a Berkeley, Calif., consulting firm and is now

Director of the Energy and Environmental Engineering Division, and became father of Christopher about three years ago with his second child born in July. . . . **Thomas Grover** is with Cobi Laboratories' research and development. On May 23, 1977, daughter Rebeka Katherin was born weighing 2.1 kgs. . . . **Jerry Abraham** is Assistant Professor of Pathology at U.C.S.D., working on occupational and environmental lung disease. Wife Harriet and he enjoy hearing from old friends and took a trip to Boston in August.

Harry Davitian obtained his Ph.D. from Cornell in applied physics in 1973 and has begun working in the energy area as a postdoctoral. He now works at National Center for Analysis of Energy Systems at Brookhaven National Laboratory, married Carlene Bryant and now has a 9-month-old son. **Roy Schwitters** is an associate professor at the Stanford Linear Accelerator Center at Stanford University, lives in Palo Alto with wife Karen and two children — Marc (5) and Anne (2). He appeared on T.V. in the B.B.C. production, "The Key to the Universe," discussing "charmed" particles.

Dennis Jedlinsky, wife Bev and three children are still living in Needham, Mass. He is Manager of Administration for P.R. Mallory Corporate Research Lab in Burlington, Mass., and also Energy Manager for the company. Bev works as a physical therapist at Faulkner Hospital. . . . **Charles Neulander** continues with General Electric Research and Development Center in Schnectady, N.Y., as a chemical engineer. He had worked for G.E. in San Jose, Calif., after graduation, and from 1971 until his present appointment worked as an engineer in the Nuclear Energy Division. He is a member of the American Institute of Chemical Engineers. He and his wife now live at 2303 Stuyvesant Dr. in Schenectady.

Richard Millman, also updating us for the first time, writes that he obtained his Ph.D. in differential geometry at Cornell, taught for one year at Ithaca College, then got his assistant professorship at Southern Illinois University in 1971. In May 1977, his first book (which he wrote with George Parker, Brown, 1967) called *Elements of Differential Geometry* was published by Prentice-Hall. He is currently negotiating for movie rights. Last year while on sabbatical he went to M.I.T. and still feels there is no place like it. On the personal side, he has two children, ages 8 and 11, is divorced as of 1975, enjoys water skiing on his 15-year-old, 75-hp boat and now lives in Carterville, Ill., and welcomes anyone who drops by to stay with him. . . . **Gene Sherman** and wife, Susan, have settled into the good life in Aurora, Colo. In July, 1977, they opened their medical offices, Aurora Medical Associates, where he is Doctor of Internal Medicine and Cardiology and Susan is Doctor of Internal Medicine and Endocrinology. They have two children, Jonathan (5), and Jill (1).

Finally, it seems that during July everyone decided to come visit Fun City. **Rick Lentz** was in then with his wife, Anne, on business. Rick is Manager of Engineering with Energy Systems Corp. up in Nashua, N. H. Rick and Anne have a son, Philip Kendrick, who is almost 2 and are expecting another arrival in October. . . . **Larry Calof** was in the city for a couple of days. Larry is a Partner with Gibson, Dunn and Crutcher in Los Angeles and he and his wife, Susan, have a son, Grant, who is now about 2 years old. They live in Tarzana. . . . **Rich Palmer** and his wife were in from Albuquerque. Rich is still with Sandia Corp. and seems to be loving the Southwest. — **Paul Rudovsky**, Secretary, 340 East 64th St., New York, N.Y. 10021

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John Rudy provided the following comments concerning our tremendously successful Tenth Reunion at M.I.T.: "Although it poured both Friday and Saturday, there was little impact on attendance, and **Joe Levangie** (our reunion chairman and marketing expert) feels that the rain-limited space at the clambake brought people closer together. We limited the reunion to Friday night and Saturday afternoon. On Friday we went to the M.I.T. Historical Collections, a new function in an old building at 265 Mass. Ave. About 95 classmates and 50 wives and dates had a buffet dinner and, among other things, viewed the old B.B.C. film about us. On Saturday we went to Wellesley College for the clambake. Although it poured, we had a great time in Alumnae Hall. Quite a few couples brought kids, and, between the unlimited food and the frisbees, everyone was kept busy. Joe Levangie did a lot of work as chairman, and there was enough help from **John Ross**, **Gary Garmon**, **Chuck Kolb**, **Jeff Wiesen**, and others, to get the job done."

The following class officers were elected: **Jeff Wiesen**, President; **Joe Levangie**, Vice President; **John Rudy**, Class Agent; **John Ross**, Treasurer; and **Jim Swanson**, Secretary. More than one-fourth of our classmates who attended are from Baker House. . . . **Ed Tripp** is with Energy Sciences, Inc., in Bedford, Mass., where he is developing processes involving electron radiation; more specifically, the curing of coatings and adhesives by non-thermal processes. Ed and the former Daryll Donnelly of Melrose were married October 23, 1976, and now reside in Wilmington.

Susan and **Mark Grossman**, who live in Princeton, are expecting their third child. Mark works for R.C.A. Americom, the domestic satellite subsidiary of R.C.A. . . . **Ted Williams** is a senior naval architect with Frederic R. Harris, Inc., in Washington, D.C., engaged in developing an experimental one megawatt ocean thermal energy conversion plant under E.R.D.A. contract. The plant will generate electricity through a closed ammonia cycle, using cold water, found at 3,000 feet below the ocean's surface, in a condenser and warm surface water in an evaporator. . . . **Andy Moorer** will be working at the new Centre Georges Pomidou in Paris for the next two years, doing his thing — computer music.

Ross Corotis, Associate Professor of Civil Engineering at Northwestern's Technological Institute in Evanston, received the Institute's 1977 "Tech Teaching Award." . . . **John Gowdy** received the first McQueen Quattlebaum Engineering Faculty Achievement Award for outstanding achievement in the College of Engineering at Clemson University. . . . In 1976 **Mark Lembersky** gave up a tenured associate professor position at Oregon State University to join Weyerhaeuser.

Ed Shalom has joined the guidance and control section of the Jet Propulsion Laboratory in Pasadena. . . . **Ted Tenny** reports: "We have a lovely little daughter Beatrix, born July 15. Last summer Jacque and I moved to Potsdam, in far upstate New York, where I am teaching computer science at S.U.N.Y. Potsdam is a small, quiet college town that's been a welcome change from the suburbs in California. Teaching is great fun. The college and town people are all friendly, but it sure gets cold in the winter."

On July 10, 1977, Sharlotte and I enjoyed the lovely wedding of **Fred Goldman** and Olivia Echeverria in San Francisco. Fred has established his own management consulting firm. Also attending the wedding were Sue and **John Hiatt** who live in Santa Rosa where John works at Hewlett-Packard. — **Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

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This month the mail has brought news from a couple of long-lost classmates, several reports from people who have found the good life, and a raft of birth announcements. It also marks my first contribution in a while — Mike finally noticed that he'd been writing most of the columns lately. Luckily, this will be an easy column to write, as a number of reports are well worth quoting.

We will start with the succinct and upbeat note from **Bob Metcalfe** reporting that "nine years, four degrees and one marriage have brought me to the peak of happiness in California, healthy, single, and building communication systems for computers." . . . **Denis Coleman** also wrote to bring us up to date on his activities of the last nine years. After the usual dissertation agonies, Denis received a Ph.D. from Stanford. He then taught at York University in Toronto until last year, when he made a well-timed move to a warmer climate just before last winter to take up his current position as Assistant Professor at the College of Business of the University of Hawaii. Since they don't play hockey there, his spare time is spent jogging and playing tennis, golf, and other Hawaiian sports. He invites vacationing classmates to call on him at the University.

Several classmates recently became parents. They include Madeleine ('70) and **Carl Rodoni**, whose daughter, Melissa Kay, was born on January 16, 1977; Ruth and **Rick Lufkin** who had a son, Graeme Walter, on June 24, 1977, and Dory and **Stephen Kanter**, whose first baby, Jordan Alexander, was born April 7, 1977, with lots of hair and big blue eyes. Steve also reports that he is leaving his job as Assistant Director of Portland's Metropolitan Public Defender Office and will be teaching criminal and constitutional law at Northwestern School of Law, Lewis and Clark College. . . . Finally, Stephanie and **Richard McPherson** reported the birth of their second child Marianne. Richard is presently Assistant Professor of Pathology at University of California, San Diego, and has another daughter, Jennifer, age 3, and a new home they are all enjoying.

We also received two reports of recent marriages. **Pete Amstutz** wrote that in May, 1976, he cast away his bachelorhood to marry Heidi Zingrich of Luam, Switzerland, who he had met in New York. Pete and Heidi had two wedding ceremonies — one conducted in German at Sigriswil, a small town in Switzerland where her family comes from, and a second one in Michigan (in English). Pete is now in his third year in London doing international merchant banking, and he travels in Europe a lot. . . . **Armen Varteressian** sends his news in the following off-hand manner: "Not much has happened to me in the past year — unless you count (A) getting married to a very nice lady (Laura), and (B) becoming a manager of software publications at Digital Equipment Corp. The two events are totally unrelated."

Rick Rudy is as active as ever on the stage. He was recently in a production of "Oklahoma!" in San Jose, and he also directed a production of Gilbert and Sullivan's "The Yeoman of the Guard"; on the side, he has a new job as Senior Quality Engineer at Spectraphysics. . . . Another of the cheerful reports this month comes from **Peter Jax**, who says, "Life is great when you are enjoying the development of an active one-year-old boy (Robbie) and when your new corportaion has its first profitable month after long hours of hard work." . . . **George Phillies** is currently working as a postdoc in the U.C.L.A. Chemistry Department and is looking around for a faculty position. . . . **Eric Weitz** reports that he has been an Assistant Professor in the Department of Chemistry at Northwestern University since 1974. . . . **Paul Bente** is with Hewlett-Packard in Avondale, Penn., doing research and development on analytical instruments. . . . **Roger O'Dell** writes that he has been working for the City of Philadelphia as a civil engineer on new mass transit projects for the past three years — currently working on a new high-speed rail line connecting the center city with the Philadelphia International Airport. . . . **Bob** and **Pat Moore** report that they will be in Lewisburg one more year, with Bob still teaching, and Pat still working at Academic Services in Bucknell's Computer Center. They report that all is very quiet there, and they also solicit information about **Alana Bixon**'s whereabouts. Alana, please check in with us!

Fred Heutink writes that he has switched jobs but is still with the same company (Philips). He is a member of the Hardware Development Group of the Industrial Data Systems section of Philips, involved in automating machines, factories, pollution monitoring networks, etc. At home, Fred and his wife continue to enjoy their two adopted Korean daughters. . . . **Gordon Logan** was recently promoted to Manager in the Management Advisory Service of Price Waterhouse and Co. I should also mention that I was recently promoted to Deputy Manager of the Support

Systems Division at Analytic Services.

Finally, we have two news releases this month. Rice University reports granting a Ph.D. in electrical engineering to **Robert Yuan-Shih Li**. . . . We also received notification that **Robin McGuire**, a structural engineer with the U.S. Geological Survey, has been granted a Research Award for Foreign Specialists by the Japanese government for three months of earthquake hazards research in Japan. He will study earthquake-caused ground motion with the aim of reducing earthquake hazards and damage to man-made structures.

Reserve the weekend of next June 9 for our Tenth Reunion. Details on planned reunion activities will be in the mail shortly and will be noted in future columns. — **Gail** and **Mike Marcus**, Secretaries, 2207 Reddfield Dr., Falls Church, Va.

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By the time this missive reaches you the frost should be on the pumpkin. This seems difficult to comprehend as the humidity is currently an almost continous 99-plus in Washington (even with the annual August reduction in hot fog emanating from Capitol Hill — it's district work session time).

We have a first-time writer to the Notes column. **Lloyd Lee Wilson** writes that he is a partner in the Willow Co. which is involved in housing and development consulting "for interesting projects only" (for example, solar heating). Lloyd received his M.A. from Sloan in May and is married to Nano Rush. This spring they will be moving to Charlottesville, Va.

John D. Fernstrom has been promoted to Associate Professor of Physiology at M.I.T. . . . **Bob Harrington** has been transferred from Dallas to California to become Director of Product Development for Synergex Corp. His wife Cynthia has set up a C.P.A. practice in Los Gatos. . . .

Another first-time writer is **Ray Smith** of Watertown, Mass. Ray spent seven years working at the Lab for Nuclear Science. Currently Ray is a software development engineer at GENRAD in Concord, Mass. (The company was formerly General Radio.) Ray is married to Arlene Ann Lee of Belmont. They have two daughters: Jennifer (7) and Leanne (8 months).

Joel Morgenstern, formerly of Bexley Hall fame (if memory serves correctly), writes that after seven very satisfying years teaching high school biology in New York City, he will be starting at Stony Brook Medical School in September. Lots of luck. . . . **Ronald L. Suffers** is now manager, M/IS Administration for Data General Corp. in Westborough, Mass. . . . **Michael E. Warren** and his wife Phyllis announce the birth of their third son, Andrew Howard, at 8:19 a.m. on January 1, 1977. The Warren's other boys are Matthew (5) and Jeremy (3). Michael is teaching at the University of Florida in the Department of Electrical Engineering.

Marilyn and **Steve Zayac** have a daughter Nicole, born in Feburary, 1976. Steve is working for Ford Motor Co. and Marilyn is "taking a few years to be a full-time mother although she may teach a course at the local community college." . . . **Ben Huie** is a Research Fellow in the Chemistry Department at Cal Tech. He is studying dioxygen complexes as models for hemoglobin. . . . **Paul David Epstein** has worked in urban government for the Lindsay Administration in New York and the Young Administration in Detroit. He is now employed by the federal government as a specialist in state and local government productivity improvement at H.U.D. He writes that he has maintained his interest and involvement in the theater by working on productions in New York and Washington.

Gary Dixon is working for Honeywell Information Systms in Phoenix. He is teaching Honeywell customers how to use Multics. . . . **Eugene F. Mallove** joined the technical staff of The Analytic Sciences Corp. in Reading, Mass., in April, 1977. Eugene shifted from breeder reactor research at Harvard to missile systems analysis at T.A.S.C. Mr. Mallove in a rather succinct and direct manner expressed his displeasure with a certain recent action taken by the current administration of the United States with respect to the breeder reactor program. . . . **Bob Davis** is a senior budget analyst in the Office of the Comptroller of the Navy at the Pentagon. His wife Kym is Program Manager of College Relations for the U.S. Civil Service Commission. He reports that Rick Barnes recently left Columbia, Md. to head back to Cambridge.

James Truitt reports that "Charmaine and I are expecting our second child in June, 1977." Their son Jimmy is now 3. Jim will finish his residency at the Bascom Palmer Eye Institute in June and enter private practice in Stuart, Fla. on July 1, 1977. . . . **John Kuiper** traveled around the world in 1975. He is now a generation planning engineer for B.C. Hydroelectric in Vancouver, Canada. . . . **George Flynn** is working for his Ph.D. at Washington University in St. Louis. He is also a part-time airplane flight instructor. He recently purchased a 37-year-old two-seater which is being used for weekend exploration of the Midwest.

Richard M. Barnes joined the Sperry Research Center in Sudbury, Mass. in May. He is jogging 6.5 miles and enjoys his three daughters, Jenny, Bonnie, and Cindy (7, 4, 1). . . . **Sam Leader** moved to San Francisco, Calif., from Hong Kong in 1975. From 1975 to 1977 he sold Computer Sciences Corp. Infonet Time sharing to the federal government along the West Coast. He is now with the Bank of America. He keeps in touch with Alec Bash, '68, who works as a San Francisco city planner.

Matt Franckiewicz reports that after five years of procrastination he received his ham license: WB3IAH. . . . **Richard A. Pinnock**, as rough and tough a defenseman as ever roamed the blueline for M.I.T.'s skating sextet, went back to school full time as of June 20 at the University of Chicago where he is working on his M.B.A.

The following quote of a statement by **Tom Scholz**, leader of the rock group "Boston", appeared in the New Haven (Conn.) *Register* on May 29, 1977: "I love engineeering. I love inventing things and so forth. But playing rock 'n' roll on stage — it's almost as good as sex. So I said, if there's some way I can do this and make a living, that'd be it." In the last 12 months "Boston" has sold 3.5 million albums. . . . **Richard A. Holthaus** has been named a vice president of Citicorp and will be moving to Manila, Philippines, where he will assume a position in Citicorp's customer services group. Previously he served in London and as managing director of Citicorp's subsidiary in Jersey, Channel Islands.

Dr. **T. C. Cheng**, head of the electric power program at U.S.C., has been honored for his outstanding contributions to teaching undergraduates in electrical engineering at U.S.C. . . . **Bruce Anderson** has published *Solar Energy: Fundamentals in Building Design,* which is apparently the first detailed reference work on good building design, passive uses of solar energy, complex solar H.V.A.C. systems, and solar water heating. Bruce is President of Total Environmental Action, Inc., in Harrisville, N.H., and executive editor of *Solar Age.*

Keep up the good work friends — **Peter Peckarsky**, Secretary, 950 25th St., N.W., Washington, D.C. 20037

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Fall Greetings. I have delayed, unintentionally, publication of information from **Howie Bluestein.** He received his Ph.D. in meterology from M.I.T. and is now an assistant professor with the University of Oklahoma. He studies tornadoes from a close vantage point in conjunction with his duties at the National Severe Storms Laboratory. . . . I also received a letter of great length from **Peter McCall**. After basketball at and graduation from M.I.T., he was awarded his M.B.A. from U.S.C. and started bookkeeping in San Diego. Peter is a "born-again Christian" and invites all to visit him.

Earl Withycombe wrote from his Sierra City, Calif., residence at the urging of **Dick Greene**. Earl has had four children and 23 different jobs. He has ended up in pollution engineering after stints as an actor, grave digger, pool hustler, etc. . . . More news from a basketball grad: **Rick Walleigh** is a cost accounting supervisor at Hewlett-Packard in Los Altos. He and his wife have a son, Adrian. . . . Having left Colorado for Crystal City, Va., **J. Davis** now is employed as an analyst in the Navy's high-energy laser program.

I received a post card from **Bob Fleischer**, in which he reveals that he left Boston for Denver and a position as a senior engineer with Martin Marietta Aerospace. He is studying human factors of interactive computer systems. **Peter Bloomsburgh** and his spouse, Martha Ramsdell, have stayed in Boston and received M.B.A.s from M.I.T. and Harvard, respectively. Both work in the Massachusetts Department of Public Welfare. . . . "Actively researching operant alternatives to the current, disintegrating cultural matrix" is the subject presently being pursued by the family of **Jim Brasunas**. His duties include blacksmithing and tending a potato field.

Steven Oreck is attempting to move into orthopedic surgery after graduating from L.S.U. medical school. . . . A classmate from my course of study of metallurgy and materials science, **P. L. Gentilman**, has recently published an article on chemical vapor deposition. He works for the Advanced Materials Department of Raytheon, after receiving his M.S. and Ph.D. from M.I.T. **Michael Theerman** lives in Worcester, has four children and has finished his residency in internal medicine. After four years in the Navy and receipt of a Ph.D. in solid state physics from Berkeley, **Mark Ketchen** has begun work in applied superconductivity with I.B.M.

Jason Zielonka graduated from Yale in medicine and is completing a residency in neuroradiology at the University of Minn. He writes that he visited **Morton Hoffman** and family in Ann Arbor, where he is working on a computer science Ph.D. . . . **Michael Bromberg** is the proprietor of Three Ring Circuits, a consulting firm specializing in electronic product design. Most recently, the products included a solar energy controller and a handheld computer terminal. . . . **Madeleine Rodoni** and Carl, '68, are parents of Melissa and are enjoying parenthood.

Classmates can locate **Philip Cochran** at Penn State, where he is an assistant professor in business administration. . . . **Clifton Buck, Jr.** is using a fellowship from his employer to pursue his M.S. in mechanical engineering at Auburn University, after receiving his M.B.A. from University of Alabama. . . . **James Griffiths** has completed duty with the Navy and with family now lives in Richland, Wash., and works as a staff engineer with Battelle Pacific Northwest Laboratories.

After his promotion to Investment Officer, **Robert Wilk** has group head responsibility for technology and capital goods investment in the research section of the Mellon Bank Trust Department. . . . The Gould Government System Division now employs **Mark Yu** after receipt of his Ph.D. in mathematics from Columbia and his M.S. in electrical engineering from Polytechnic Institute of N.Y. . . . **R.J. Polinsky** has completed a residency in neurology at Johns Hopkins and will start a fellowship at the National Institute of Mental Health.

Julie Norton greets everyone and states that she has completed three years as an assistant professor at California State and now has her Ph.D. in statistics from Harvard. . . . A somewhat feverish **Jeff Gale** has garnered the most degrees. He was bestowed with an M.S.A. from Sloan, a J.D. from U.C.L.A. and a Ph.D. in management from U.C.L.A. **Ed Markowitz** was Jeff's best man at his wedding. Jeff now works in Seattle as a faculty member at the University of Washington.

Some kindly persons do respond to this writer's pleas for material. June Gladney, who is writing for **Ernie Gladney**, tells of "high living" in the mountains of New Mexico. Ernie works at Los Alamos Scientific Labs in the areas of analysis and technique development. The family backpacks in the open spaces and mountains. . . . Evidently, **Skip Jackson** lives there also and has a Ph.D. in nuclear chemistry. He has a motorcycle

and a post-doctoral at the lab, but needs a house. . . . **Phil Byer** wrote that he is an assistant professor in civil engineering at the University of Toronto and teaches social and economic analysis of engineering projects. Phil mentioned that his spouse is a professional folksinger.

Your writer enjoyed an active summer and early fall. The family traveled to Colorado and elsewhere. The law practice is expanding and my office is now completely furnished with oak antiques. — **Robert Vegeler**, Secretary, Kennerk, Dumas, Burke and Backs, 2120 Fort Wayne National Bank Bldg., Fort Wayne, Ind. 46802

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Ann Kivisild Smith writes that her husband, Steve, '70 is working for a Ph.D. at M.I.T. and hopes to be done Christmas. Ann is taking piano lessons and rearing their two sons, Craig (December, 1973) and Geoffrey (April, 1977). Thanks for the nice note, Ann. . . . **Marty Jack** is working for Digital Equipment Corp. in Maynard, Mass., developing compilers for the BLISS language. He bought a house and two cats in Maynard. . . . **Nancy (Greene) Burstein** writes that she and Phillip are beginning their third year of teaching at Purdue and that they are looking forward to their first child in the end of January. . . . **Mike Borowitz** has finished the Duke M.D.-Ph.D. program, and from the explanation points on the note I think he's pretty excited. . . . **Patrick B. Sullivan** writes: "Finally getting our small company off the ground. Latest contracts are for pattern recognition software at Ft. Belvoir, Va., and drone guidance software for the Air Force. . . . Also trying to get back into decent shape for an appearance in the varsity alumni track meet. **Kevin McEntee** writes: Began Ph.D. program in biophysics at University of Chicago in 1971. Married Margaret (Peggy) Parskey (Simmons 1971) in December, 1972. Peggy received an M.S. in statistics at the University of Chicago in June, 1973; I received my Ph.D. in biophysics/theoretical biology in June, 1976. Peggy is now finishing her M.B.A. Program while I am doing postdoctoral work here in biochemistry."

Gerald E. Loe has finished at the Harvard Business School and is going to work for Tektronix in Beaverton, Ore. . . . **Charles A. Kaufmann** writes: "Following a brief career as a junior high school mathematics teacher, I attended Columbia College of Physicians and Surgeons and am beginning a psychiatry residency at Payne-Whitney Clinic, New York Hospital, Cornell Medical Center." **Benjmain P. Feng** is with Citibank in New York as a consultant in international finance and foreign exchange, helping multinational corporations solve their problems. . . . **Terry K. Kellerman** is a systems planning analyst at Intel Corporation, after having received a master's in operations research at the University of California. He has formed a small computer games company, Strategematics Co., as a sideline. . . . **Roy L. Whiddon** has emigrated to Canada and is currently working as a computer scientist for Northern Telecom (the telephone company) in Montreal. He's also become a 35-mm. camera bug.

Dubose Montgomery is the President of the M.I.T. Club of Northern California — just goes to show what will happen when you put a southern boy in a western state. . . . **Mark Pasternack** writes: "Judy Meyers (Wellesley '72) and I were married on February 27, 1977. She is beginning her thirdyear at Northeastern Law School which I am finishing up my residency in medicine at Mass. General. This year I will be a senior resident and in July, 1978 I will begin a two-year fellowship in infectious diseases at Mass. General." . . . **Douglas N. Gordon** is married, with two children and is an attorney with Rosenman, Colin, Freund, Lewis & Cohen in New York City. . . . **J.P. Glowienka** writes: "My wife, Lindan, and I have moved with our two cats and 250 plants to Atlanta. I accepted a transfer to work in sales for the Corrugated Division of the Continental Group (nee Continental Can Co.) Too bad! I had just run into **Jack Hiatt** in Norwalk, Conn. I believe **Jim Shield**, is running around down here."

Grethe Holby writes: "I have just completed a N.Y. performance with the Katherine Litz Dance Co., and in February will present my first N.Y. concert of a piece of my own, "Dancers (on view)." I am teaching dance part-time at Ramapo College of N.J. and am relieved that the term is completed." Grethe enclosed a review of her work by *Dance Magazine* which was presented at the American Theatre Lab. The review is a bit too lengthy to quote in full, but it described the piece and ended with the following: "Dedication, I guess, is what Holby's dance was about — triumph over natural rebellions of the body and the mind. If it was more an essay on dance than a dance itself, it was nonetheless a valid and effective exercise in design." . . . **Paul Figa** was recently married, to the former Gail A. Livingstone. Gail is working for Boston Gas as well as attending Quincy Junior College. Paul is a programmer for the New England Medical Center.

The summer in Brenham has been hot and dry. Lucy and I took a vacation to Natchez, Miss., and St. Francesville, La., to see some of the plantations. It was interesting to see the ingenuity and the wealth of those people. Please keep writing and stop in if you are in Brenham. — **Hal Moorman,** Box 1808, Brenham, Tex. 77833.

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Greetings once again from Chateau Fairbanks, the beautiful Brighton mansion, about to become the property of your friendly correspondent. **A.H. Barber**, Lt. J.G., is leaving his present assignment on the *U.S.S. Kinkaid* and entering a M.S. program in electrical engineering at the Navy's postgraduate school in Monterey, Calif. A.H. was married to Tina Fagan (Colorado Nursing School '73) on December 21, 1976. . . . **Greg Myers** is living in Berkeley and enjoying the area. He works at Lawrence Livermore Lab, doing computer image processing. This fall finds him in Africa.

David Porush sends a long letter to the effect that he has received a Ph.D. in English at Buffalo, while able to meet a number of great American novelists through a project of his. Next fall will deposit him in a position as Assistant Professor of English at William and Mary. Meanwhile, Dave is playing copious amounts of softball and awaiting word on the fate of *Rope Dances*, his short story collection. More to come from his productive brain literarily. Dave also sends his seal of approval on the new '73 column, as did Greg and A.H.; for which I am sincerely grateful.

Steven Warsof participated in a recent A.M.S.A. forum where he was cited for outstanding work in obstetrics. Dr. Warsof received his M.D. from Yale. **Bill Stern** just graduated from medical school as well; Mount Sinai his alma mater. He will be interning at George Washington University Hospital. . . . **Irv** and **Jean Paskowitz** now have two boys, Danny (Oh, Danny Boy. . . .) (2) and Mike (4 months). They keep busy with them and with working for Monsanto. Jean is Vice President and Irv a governor of the M.I.T. Club of St. Louis, and are both on the Educational Council.

Paul Balian has moved down the road to help incorporate Creative Comfort, a furniture enterprise. Last summer, Paul graduated from Tech Dinghies and was one of three who sailed a 50-ft ferro-cement ketch from Clearwater to Grand Isle, La. **Mark Freundel** graduated with a J.D. from law school at the University of Maryland in June. **Lubomyr Zyla** has received his Ph.D. from Rice; his dissertation: "Techniques for Non-linear System Approximation and Identification Based on Volterra Expansions." (Mine was called "Our Friend, the Beaver.")

Yours even more anorexially has squeezed his famous "bod" from the 176 pounds loosely distributed on 5'7" all through college, med school (aborted), opera, etc., down to 137 as of today. Bear me no envy — the money saved on food is more than eaten (no pun intended) by the expense of tailoring my suits again. See, I told *TR* you'd all never remember me! — **Robert M. O. Sutton**, Secretary, 37 Fairbanks St., Brighton, Mass. 02135

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Paul Mailman writes that at the end of June he started work with the Educational Services Division at Digital Equipment Corp., Maynard, Mass. He instructs employees and customers in the use of particular systems that D.E.C. develops. . . . Bob Cutler, '73 seems to be in Ann Arbor, Mich. . . . **Mike Kraft** writes: "I'm still single and happy. August, 1977, I started at Boalt School of Law at the University of California at Berkeley. As always, my interests are diverse; I'm now a good backgammon player and I've been studying mime." He'd like to renew contact with friends who might be in the Bay area.

Marriages: **Robert King Dutton** married Jean Louise Collins on May 14, 1977; Bob is an engineer for G.T.E. Sylvania. . . . **Eve Bookspan** married Irwin Hollander, an M.I.T. graduate student in biochemistry, in November of 1975. Eve teaches math at Malden High School. She received a master's in math education from Boston College. . . . **Edwin M. Arippol** was married in August, 1976, and is a self-employed consultant in Brookline, Mass. . . . **E. Martin Davidoff** married Sheila Temkin on May 30, 1976, and is completing his second year of law school at Washington University in St. Louis, Mo. . . . **Dallas Hellen Abbott** married Bill Menke, '76, on August 21, 1977. Both are Ph.D. candidates at Lamont-Doherty Geological Observatory of Columbia University. . . . **Thomas Wolff** is engaged to Marcy Epstein, Stanford '77. Tom is working on his Ph.D. in chemistry at Stanford. Marcy will be at Stanford's medical school in the fall. . . . **Jonathan Tepper** is engaged to Ruth Fiescher, Simmons, '75, and is working for Dynamics Assoc. in Cambridge, Mass.

Benjamin Svetitsky is a research assistant in the theoretical physics group at the Stanford Linear Accelerator Center. . . . **J.C. Holland** is building bridges in the Ozarks of Missouri and Arkansas. . . . **Charles E. Calhoun** was working at the Burroughs Corp. as a management systems analyst and returned to the Wharton School of Business at University of Pennsylvania in the fall. . . . **Tom Howard** is making a few hundred tons of steel now and then in northwestern Indiana and carpooling with Eric Knoor.

Philip Jay Doucet is "still trying to sell energy conservation, but companies aren't rushing to buy." . . . **David D. Withee** is in Toledo, Ohio, as executive director of Junior Achievement Conference: "I plan to enter the Boston marathon in 1978." . . . **Steven Harris** is Director of Information Systems at Evanton Hospital. . . . **Bruce Judelson** has graduated from Harvard Law School and will be working for Nutter, McClennen and Fish in Boston. . . . **Drew Jaglom** also graduated from Harvard Law School and will be working for Paul, Weiss, Rifkind, Wharton and Garrison in New York. . . . **Mike Glenn** "finally graduated from the University of Michigan Law School. I have embarked on a career as a patent attorney with the Dow Chemical Company."

Ray Van Houtte is working on an M.S. in agronomy at Cornell. . . . **George Arzeno** is beginning his fourth year at Columbia University College of Physicians and Surgeons medical school. George will be marrying in June. . . . **Frank Morgan** received his Ph.D. in math from Princeton University this year and returned to M.I.T. as an instructor. . . . **Stanley D. Young**'s wife Jasmine Lim, Wellesley, '74, has just completed her first year of graduate school in city planning at the University of Washington. He says that we should all see Seattle; its a beautiful city.

Missy Mink is a graduate student at Cornell in animal behavior and behavioral ecology. . . . **Bruce Schobel** is working for Prudential Insurance Co. in Newark, N.J., and has recently been named a fellow of the Society of Actuaries. . . . **Rodney C. Hartman** has received his M.D. from the University of Nebraska Medical Center. He will be a resident at the University of Kansas Medical Center. . . . **Eliot Spindel** was recently named an M.I.T. Health Sciences Fellow. — **Dennis Dickstein**, Secretary, 17 Forest St., #34, Cambridge, Mass. 02140

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I've once again gathered enough cards and letters together to write a column. Many thanks to those of you who dropped me a line over the summer.

Roger White is now working for Thiokol Corp. outside Brigham City, Utah, on the development of the Space Shuttle solid boost rocket. According to Roger, it's the biggest of its kind, weighing 10^6 pounds. He says he's living in Salt Lake City and commutes to work by flying an airplane. Aside from this, he's "Still active in playing dungeons and dragons and river running when there is any water out here." . . . **F. Carl Mueller** completed a 15-month stint in VISTA, as well as a stay in academia. He now is proud possessor of an M.S. in Nutrition and an M.P.H. in International Health. He is studying for the Doctor of Public Health at Columbia University where he's very much enjoying it. . . . Another content classmate is **Paul R. Giguere**, who has been with Water Resources Engineers, Inc., for a year, working mainly in the area of water quality modeling. He recently bought and moved into a townhouse in Walnut Creek, Calif. He loves the area and the job and plans to stay there for a while.

Jeffrey Freedman is still a graduate student in math at U.C.L.A. . . . At least two of us have broken out of the student mode to assume the role of teacher. **Norris Preyer, Jr.** began teaching physics at the McCallie School in Chattanooga in June. He had been a grad student in astronomy at the University of Chicago up until September, 1976. . . . **Sandra Kelly** is teaching high school math as well as coaching gymnastics in Reading, Mass.

And now for some nuptial news: **Stanly R. Jackson** married Carol Ann Marcinowski. According to the *Boston Globe,* after a trip to California, they returned to Massachusetts to live in Quincy. . . . **Carol Livingstone** writes, "Last August (1976) I married Daniel Grayson (Ph.D., math, 1976). I'm in my second year of graduate school at Columbia University in the Department of Physiology. I got my master's degree this year and I'm working towards a Ph.D. In my spare time I've been taking voice lessons and doing musical theatre. Last term I played Kate in "Kiss Me, Kate," a production put on by a group at the Columbia Medical Center." Carol ran into **Cecelia Lo** at a symposium in New York. She's married and is a graduate student at Rockefeller University..

Jeff Schweiger is serving with Navy Patrol Squadron 19 in San Francisco as a navigations/communications officer and as ground safety officer. He has been promoted from ensign to lieutenant (j.g.). Come December, his squadron will spend six months at Kadena Air Base in Okinawa. Last spring he was sent to school in San Diego for a few weeks, where he saw **Janis Weeks**, a grad student in biology at U.C.-San Diego, and **Jeff Star**, who is doing grad work in marine ecology at Scripps Institute. In the Bay area, he had the opportunity to get together with a few more classmates. **Nancy Bell** is in Berkeley working for Bechtel. **Diane Gilbert** finished up at U.C.-Davis and is returning to the Boston area to work for Walden Research Corp. **Diane Bracken** has finished some work at Stanford and will remain in the Bay area to work for Hewlett-Packard. Also, **Alwin Okuna** will be coming to San Francisco from Los Angeles to work for Hewlett-Packard. Jeff has also heard from **Paul Husby**, who is doing managerial consulting in the Minneapolis-St. Paul area, and **Paul Paffe** who is in theological seminary in St. Louis.

And one final happy announcement that I managed to get wind of through my grapevine. On July 28, 1977, **Joyce** and **Chris Demain** became parents of a baby boy, Brian Neil.

Anyone else out there with news? I'd love to hear from you at my new address. — **Jennifer Gordon**, Secretary, 22 Centre St., Suite 9, Cambridge, Mass. 02139

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We have a fair mixture of news from over the summer — but too few people have written. However, enough complaints, and on with the news.

Keith Serra has married Jeanne Sullivan, a Simmons alumna, on July 24. They are taking up residence in Roslindale, Mass. As for what either Keith or Jeanne are doing for a living, I do not know. More details would be appreciated. . . . **Michael D'Amato** has finished the Harvard "B" School. After completing M.I.T. in 1975, and after working very, very hard, as I remember it, he also did a fine job at Harvard. He graduated as a George F. Blake Scholar, an academic honor reserved for the top 5 per cent of a graduating class of 728. Well done, Mike! . . . **Russ Jacoby** writes that he is "pursuing a Ph.D. in Biophysics at the University of Chicago and living in the Hyde Park area of the city with three medical students; alumni of Wellesley, Harvard, and Brown."

I mave a marvelous letter from **Marsha Lavoie**. She and **Larry Hardy** are in Berkeley. She writes that after almost a year away from Cambridge, they are beginning to adjust to the California experience. One curious result of the change has been that Larry has developed allergies and Marsha has lost hers! Marsha took a chemistry course at Berkeley and found that she could handle it with ease. "Now that I have my M.I.T. years behind me, I guess I can handle anything!" Plus, she is doing volunteer work at a contraceptive clinic and has been looking for a part-time job with no success, owing to the very high unemployment rate of 15 to 18 per cent. And as for Larry, he has begun his biochemistry thesis research. His topic is to isolate and characterize the enzyme in some strains of gonorrhea which gives them immunity to penicillin. Hopefully, he will also find a method to inhibit the enzyme's activity! They are therefore going to be in the area for another three years and welcome any alumni to stop by and say hello. In closing her letter she writes something I find comforting. . . . "I would like to say that we both miss Cambridge and even M.I.T. As much as we may have cursed the 'Tute while we were there, we now realize what a good deal we had there. The University of California pampers its students much less than M.I.T. does. We never knew how good we had it at M.I.T.! Imagine having to *buy* your own blue books for exams — that's how it is at U.C." Are the rest of you having similar feelings and experiences?

The night before these notes were due, I had the pleasure of bumping into several classmates. I saw **Peter Horowitz** and **Joan Pendleton** while bowling at the Student Center. Peter is still working on his next degree at the 'Tute. Joan is at Stanford, going for an M.S. in electrical engineering. However, she told me that the spring semester was spent "actually, rowing a lot, eating a lot, sleeping some, and drinking champagne!" Plus, she gave news to me of other people also at Stanford. . . . **Linda Yester** got an M.S. in operations research and has happily left school to make money. **Dave Gifford** and **Larry Stewart** are both enjoying California life more than Stanford. **Rob Shultze** got his M.S. in civil engineering. **Gordon Smith** is still there, as is **Chip Laub.** Joan saw **Ira Gerson,** who is working for Motorola in Chicago and is fine.

Later that evening, I saw **Raphael Blumpkin** in Harvard Sq. Unfortunately, we did not have time to talk for very long, but in the course of our chat he did give me a quite memorable quote about how his life is these days. "I just got through with adolescence, and it was quite a struggle." Raphael was in Cambridge for the summer doing more consulting. In the fall, he will resume his studies at the Cornell Business School.

I am pleased to report that **Jean Hunter** and Thomas Hurasuma were married on August 13 in Princeton. I expected this to happen! Jean, when I last heard from her, was working for Proctor and Gamble in Cincinnati, and Tom was with DuPont in Delaware. I hope they are not commuting to their jobs out of somewhere in the middle!

A note from **Hal Berman** indicates that he will marry Cindy Husmann, '78, in May of 1978. He also reports that **Steve Goode** married Meri Whitaker, '79, on June 12. Plus, some news of **Bob Quirk**, our Navy nuclear person. Bob got transferred to Saratoga Springs, N.Y.

Mike Rucker has answered my request for some details of his new job. He is working for the Iroquois Research Foundation doing archeological site surveys. He apparently does a fair amount of surveying plus has become a jack-of-all-trades, doing whatever needs doing. He has seen **Pete Garcia**, who is working for N.R.C. And he reports that **Todd Harland-White** and wife Faith have moved to Vallejo, Calif. Todd is working Westinghouse's Oceanic Division.

As I went to deliver these notes to *T.R.,* I almost ran over **Bernardo Wolfson**. He went back home to Anacao to vacation for a while after finishing up, and then came back to Cambridge to relax some more and play tennis. What a life! In the fall he will be at the Wharton School of Business. And as I entered E19, I saw Noreen Hickok, '75, who told me that in June **Peter Okin** married Lisa DeAngelis, Wellesley '77. Peter is at Cornell Medical, and Lisa will be at Columbia's College of Physicians and Surgeons.

It has been a good summer for news. But that does not mean you should not write! So, have fun, and tell me about it (or even the rotten moments!) — **Arthur J. Carp**, Secretary, 67 Badger Cir., Milton, Mass. 02186

77

Well, here it is, the first of what may prove to be a long series of informative class notes. The dust has cleared somewhat and people are getting settled into the business world or trying to finish moving to the grad school of their choice. I've been kicking around various places along the eastern seaboard so information may not be quite as accurate as it could be.

To start things off, **Dave Dobos**, our illustrious class president, has finished his thesis and headed South for the next few years to S.M.U. Law School, (it ain't Columbus but it'll do). The West Coast has managed to lure a number of people; especially to the Bay area, drought and all. **Cliff Edson** heads for a life of leisure at Stanford in a joint Civil Engineering/Business School venture. **Randy Wilson** is also looking forward to a stay at the Stanford Country Club working on more video-oriented projects. On the other side of the Bay, **Jack Reeves** will be helping bettors with his graduate studies in statistics at Berkeley. Any one else planning to be in the San Francisco area, don't forget to B.Y.O.B. (of water that is). Further North on the Pacific Rim will be **Kenny Sun** at the University of Washington in Seattle in their aero/astro grad school. Moving back toward the Midwest, **Craig Johnston** will be at Michigan State in the doctoral program there. On a different note, **Arlie Sterling** will be relaxing and galavanting across Europe for a year doing some fencing as well, I'm sure. **Jim Walton** is in the army and down in steamy Georgia for training.

Many of our classmates are headed off for Medical School. **Renan Beckman** is off to scenic downtown Baltimore and Johns Hopkins Med, **Pete Kwon** heads for "The City" as does **John Krolewski** for Columbia and N.Y.U. respectively, and, **Al Glombicki** goes home to Chicago and the U. of Illinois Med School.

Hewlett-Packard has latched on to **Jim Pollock** as a sales engineer and assigned him to Atlanta, only a couple of hours away from his fiancee. **Eileen Schaffer** is busy being a Californian, heart and soul, while working for Livermore Labs in Davis, Calif. Finally, **Jeff Singer** is taking a rest from stopping lacrosse balls and working for Watkins-Johnson in Gaithersburg, Md.

As for myself, I'll be at Sloan for the next couple of years. Any information about classmates, their doings, and addresses, will be warmly welcomed. A promise to reply to all letters is in order and if anyone writes it won't just get filed away. I hope to hear from people soon and let me know your whereabouts. That's all for this first edition. Please write. — **Doug McLeod**, Secretary, 11 Silvey Place #1, Somerville, Mass.

ALUMNI TRAVEL PROGRAM 1977-78

This special travel program, to some of the most interesting areas in the world, has been especially designed for alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Dartmouth, Univ. of Pennsylvania and certain other distinguished universities and for members of their families. It is consciously planned for persons who normally prefer to travel independently, and covers lands and regions where such persons will find it advantageous to travel with a group.

The itineraries are designed for the intelligent traveler, and offer an in- depth view of historic places, ancient civilizations, archeological sites and artistic treasures, as well as interesting and far-flung cultures of the present day and spectacular scenery from virtually the four corners of the globe. The programs are, however, also planned to incorporate generous amounts of leisure time and to avoid unnecessary regimentation so as to preserve as much as possible the freedom of individual travel, while utilizing the savings and the practical convenience which group travel can offer.

Considerable savings have been obtained by using special reduced fares offered by the world's leading scheduled airlines, fares which are generally available only to groups or in conjunction with a qualified tour and which offer savings of as much as $500 and more over normal air fares. In addition, special group rates have been obtained from hotels and sightseeing companies. By combining these savings with a careful selection of the finest available hotels and facilities, it is possible to offer travel arrangements of the highest standard at moderate and economical cost.

AEGEAN ADVENTURE — 23 Days: The archeological treasures of classical antiquity in Greece and Asia Minor and the islands of the Aegean, with visits to Constantinople (Istanbul), Troy, Pergamum, Smyrna (Izmir), Sardis, Ephesus, Epidauros, Mycenae, Olympia, Delphi and Athens, as well as a cruise through the Aegean to the islands of Crete, Santorini, Mykonos, Rhodes and Patmos. Departures April through October.

MEDITERRANEAN ODYSSEY — 22 Days: An adventure into realms of antiquity in the western Mediterranean, with the ruins of Carthage and the Roman cities of Africa in what is now Tunisia, the splendid Greek temples of Sicily (including the famed "Valley of the Temples" at Agrigento and the ruins of Syracuse, the city of Archimedes), the remarkable Norman churches of Palermo, dating from the age of William the Conqueror, and the fortress cities of the Crusader Knights of St. John on the island of Malta. Departures March through October.

VALLEY OF THE NILE — 17 Days: A detailed view of one of the greatest civilizations the world has ever known, the civilization of ancient Egypt along the valley of the Nile. The itinerary includes Cairo, the pyramids of Giza, Sakkara, Dashur and Meidum, Memphis, Abydos, Dendera, the great temples and monuments of Luxor, including the Valley of the Kings and the tomb of Tutankhamun, and a cruise on the Nile of Upper Egypt to visit Esna, Edfu, Kom Ombo and Aswan, as well as the great monumental temples of Abu Simbel near the border of the Sudan. Departures January through December.

THE ORIENT — 29 Days: A magnificent survey of the Orient, including the exotic temples and palaces of Bangkok and the ruins of ancient Ayudhya, the great metropolis of Singapore, the enchanted island of Bali with its unique artistic heritage, the famed port of Hong Kong on the border of Red China, and a comprehensive visit to Japan which places special emphasis on the cultural treasures and the tranquil beauty of classical Japan at the historic city of Kyoto and at Nara, Uji, Kamakura and Nikko, as well as the mountain scenery of the Fuji-Hakone National Park and the modern capital at Tokyo. Optional visits are available to the ancient temples of central Java and the art treasures of the National Palace Museum in Taiwan. Departures March through November.

BEYOND THE JAVA SEA — 32 Days: A remarkable journey through the tropics of the Far East, from the port of Manila in the Philippines to the tea plantations and ancient civilizations of Ceylon, the Malay Peninsula, the Batak tribes of Sumatra, the ancient temple ruins of Java, the fabled island of Bali, headhunter villages in the jungle of Borneo, and the unforgettable beauty of the lights of Hong Kong. Departures January through November.

MOGHUL ADVENTURE — 30 Days: The great historic and cultural heritage of India, combined with the splendor of ancient Persia and a journey into the high Himalayas in the remote mountain kingdom of Nepal: imposing Moghul forts, ancient temples, lavish palaces, the teeming banks of the Ganges, snow-capped mountains, picturesque cities and villages, and the Taj Mahal, culminating with the famous mosques of Isfahan and the 5th century B.C. palace of Darius and Xerxes at Persepolis. Departures January through November.

SOUTH AMERICA — 28 Days: An unusually comprehensive journey through the vast continent of South America, from the Inca ruins and colonial heritage of the western coast, amid the towering snow-capped Andes, to the great Iguassu Falls and the South Atlantic beaches of Brazil. The itinerary includes the colonial cities of Bogota, Quito and Lima, the great Inca centers of Cuzco and Machu Picchu, La Paz and Lake Titicaca, the magnificent Argentine Lake District at Bariloche, Buenos Aires, the Iguassu Falls, Sao Paulo, Brasilia and Rio de Janeiro. Departures January through November.

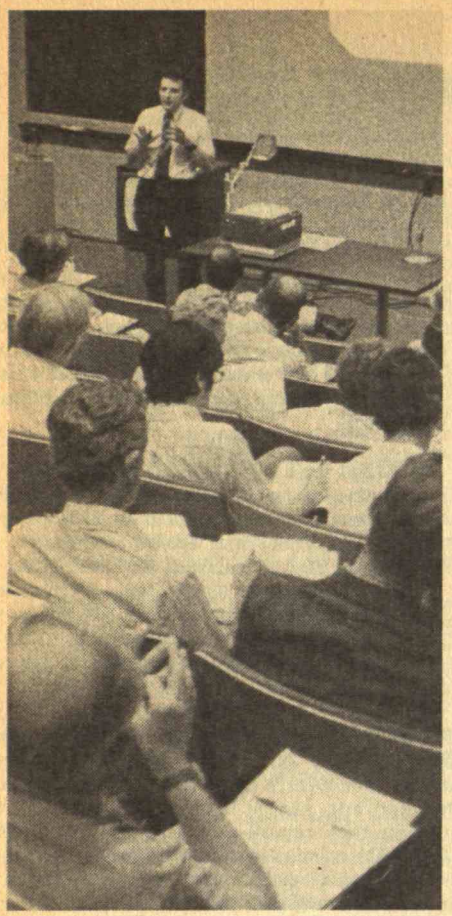
THE SOUTH PACIFIC — 28 Days: An exceptional tour of Australia and New Zealand, with Maori villages, boiling geysers, fiords and snow-capped mountains, ski plane flights, jet boat rides, sheep ranches, penguins, the real Australian "Outback," historic convict settlements, and the Great Barrier Reef. Visiting Auckland, the "Glowworm Grotto" at Waitomo, Rotorua, the Southern Alps at Mt. Cook, Queenstown, Te Anau, Milford Sound and Christchurch in New Zealand, and Canberra, Tasmania, Melbourne, Alice Springs, Cairns and Sydney in Australia. Optional extensions available to Fiji and Tahiti. Departures January through November.

EAST AFRICA — 21 Days: A distinctive game-viewing and photographic safari to the wilds of Africa, covering some of the greatest wildlife areas in the world. From the semi-desert of Kenya's Northern Frontier region and the vast game-filled plains of the south to the lakes of the Great Rift Valley and the snow- capped peak of Kilimanjaro, the itinerary includes Nairobi, the Nairobi National Park, Treetops, Meru National Park, Samburu Game Reserve, the Mt. Kenya Safari Club, Lake Nakuru National Park, Lake Naivasha, an extended stay in the great Masai-Mara Reserve, Amboseli National Park and Tsavo National Park, with optional visits to the coast at Mombasa and Lamu. Departures January through December.

Prices range from $1,995 to $3,406 from U.S. points of departure. Fully descriptive brochures are available on each tour, setting forth the itinerary in detail with departure dates, relevant costs, hotels used, and other information. For full details contact:

ALUMNI FLIGHTS ABROAD

White Plains Plaza, One North Broadway, White Plains, N.Y. 10601



Albert Vezza, Research Associate in M.I.T.'s Laboratory for Computer Science, to the first Alumni Summer College in Cambridge (above): at least 100 computers are now working together, drawing on each other's special capabilities, in a network developed under auspices of the Defense Department's Advanced Research Projects Agency (A.R.P.A.). A major hurdle, which took three years of maneuvering and cajoling, was persuading computer specialists at each facility to design the hardware and software needed. Now even more computers could be welcomed into this information-based fellowship. (Photo: Roger N. Goldstein, '74)

Cambridge Alumni Summer College Investigates Computers: Possibilities and Inherent Limitations

No doubt Aspen is a delightful spot for an alumni summer college — and no doubt the alumni who traveled long distances to convene there were richly rewarded, as the photos and report on page A8 testify. But the week before, nearly 100 alumni, spouses and children in tow, also gathered in Cambridge — not the obvious vacation resort.

They had come to investigate "The Computer: Your New Man Friday." They lived on campus, ate in student dining halls, and spent a good part of each day listening to talks in the new Chemical Engineering Building (its air-conditioned lecture hall a welcome retreat). The Aspen colloquy may have been billed an "alumni summer college," but the intrepid alumni who met in Cambridge experienced the real thing.

What brought them to M.I.T. in July?

Many alumni looked forward to renewing school ties, and observing in what ways M.I.T. had changed or had remained the same. Alumni with college-age children welcomed the opportunity to introduce them to alma mater, and to other institutions in the area (trips and pre-college discussions led by M.I.T. students, recent graduates, and administrators kept most of these kids busy throughout the week). Younger children were treated to a week-long day camp, giving their parents a chance to relinquish the apron strings for a bit.

But perhaps the most compelling incentive was the stellar roster of computer experts on hand: Robert M. Fano, '41, Ford Professor of Engineering, who acted as Master of Ceremonies; Kenneth H. Olsen, '50, President of Digital Equipment Corp.; William S. Grinker, '56, and Adolf F. Monosson, '48, Vice President and President, respectively, of American Used Computer Corp.; David C. Walden of Bolt Beranek and Newman, Inc.; Jeffrey A. Meldman, '65, Professor of Management; Patrick H. Winston, '65, Director of the M.I.T. Artificial Intelligence Laboratory; Nicholas Negroponte, '66, Professor of Architecture; Barry Vercoe, Professor of Humanities (and composer of computer music). From the Department of Electrical Engineering and Computer Science were Professors Steven A. Ward, '66, William A. Martin, '60, and Joseph Weizenbaum. And from the M.I.T. Laboratory for Computer Science were Albert Vezza, Research Associate, Joel Moses, M.A. '67, Associate Director, and Michael L. Dertouzos, Director.

These authorities guided alumni from the computer's infant development (a highlight was a videotape of Edward R. Murrow interviewing a very collegiate Jay Forrester about M.I.T.'s first Whirlwind computer) to its maturity as a tool for communications, medicine, linguistics, education, art, music, and games. Alumni learned the Delphi computer language and took advantage of hours of supervised time on the machines, playing games to see what computers can do. (Word has it that no one beat the machine.)

At week's end, their heads filled with the glorious prospects for computer-aided work and play, the participants were brought up short with a discussion of the computer's social costs. The possibilities for such criminal activities as computer snooping and falsification of records are not all we must anticipate and learn to prevent. Perhaps more dangerous, argued Professor Weizenbaum, is our misunderstanding of computer "intelligence"; if we revere computers, we may lose respect for our own humanity and come to regard ourselves as simply dumb versions of an immortal and omniscient machine. But the more knowledge laypeople have about computers — their possibilities and their inherent limitations — the less likely we are to make this mistake, said the conferees. And perhaps ultimately the participants in this first alumni summer college came to M.I.T. on the strength of this perception — eager to learn what makes computers work, most eager to discover what makes them machines, what makes us human. — *D.McG.*

"Great Style . . . Handsome Tone" On New Symphony Recording

The third of a four-record debut on a major record label by the M.I.T. Symphony orchestra is now in music stores across the country. It's a special debut of its own — the first recordings ever of two major modern compositions:

☐ "Sonata da Chiesa," by Frank Martin, in the version for viola d'amore and string orchestra.

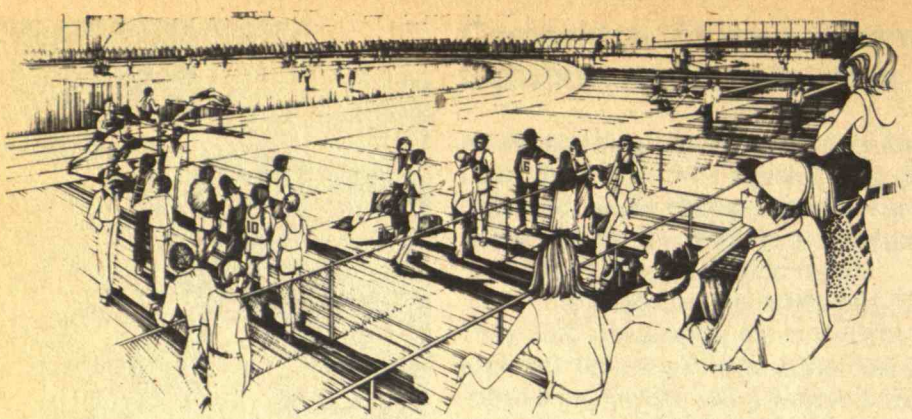
☐ "Suite Hébraïque" for viola and orchestra, by Ernest Bloch.

The new record, on the Vox/Turnabout label, also includes Paul Hindemith's viola concerto based on old German folk songs, "Der Schwanendreher."

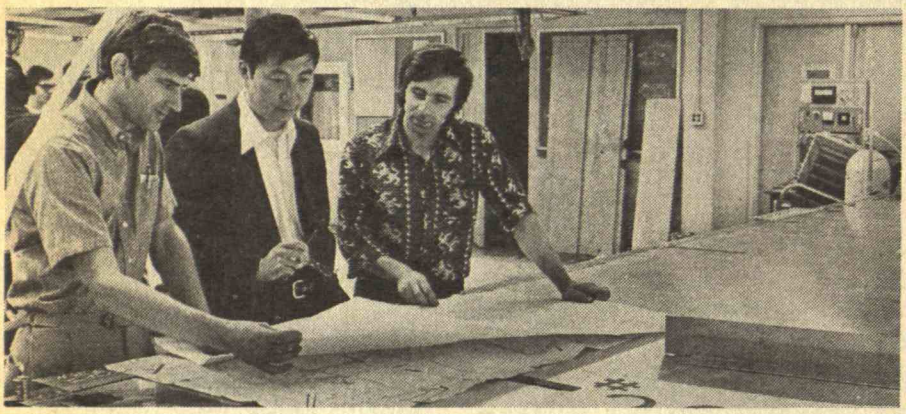
The soloist in all three works is Marcus Thompson, Associate Professor of Music at M.I.T. who is regarded as "one of the brilliant solo violists of his generation." The Orchestra is conducted by David M. Epstein, Professor of Music.

The first record in the series, released early this year, contains Aaron Copland's "Dance Symphony" and Walter Piston's "Suite from the Ballet, The Incredible Flutist"; the second record features pianist Abbott Ruskin playing piano concerti by Copland and Samuel Barber.

After a performance of Paul Hindemith's viola concerto "Der Schwanendreher" by Professor Marcus Thompson with the M.I.T. Symphony Orchestra in the Kennedy Center last year, Paul Hume wrote in the Washington Post *that "Thompson is an elegant musician who plays with great style and handsome, silky tone." The same work has now been recorded, along with two other compositions for viola and orchestra, by the M.I.T. Symphony under the direction of Professor David M. Epstein on the Vox/Turnabout lable of Vox Productions, Inc., of New York.*



It's not the mammouth extravaganza typical of a Big Ten university, but the Henry G. Steinbrenner ('27) Stadium, nearing completion this fall on Briggs Field, is fully appropriate to M.I.T. A 400-meter running track and other areas for field events — covered with an all-weather synthetic surface — will enclose a turf-covered playing field, and there will be seating for 400 spectators. Mr. Steinbrenner, the donor, was a star of M.I.T.'s intercollegiate track team while a student in naval architecture and marine engineering, and he's the only M.I.T. runner ever to have won an outdoor national track championship.



The "J" particle may be infinitesimal and volatile, but experiments to study it are ever more massive. Samuel C. C. Ting (center), Thomas Dudley Cabot Professor of Physics, is now at the European Center for Nuclear Research (CERN) with 200 8-by-19-foot detection chambers such as the one shown in this picture; he's searching for more powerful members of this new family of mysterious high-energy phenomena. Dr. Ting shared the Nobel Prize in 1976 with Professor Burton Richter, '52, of Stanford University for the original "J"-particle discovery. With him in the picture are David M. Osborne (left) and Peter Berges, staff scientists in the Laboratory for Nuclear Science. (Photo: Calvin Campbell)

What the Professors Earn

Full professors at M.I.T. earned an average of $34,500 on a nine-months basis in 1976-77, according to figures from the National Center for Education Statistics compiled by the American Association of University Professors. That's significantly less than Harvard's average of $38,500, barely above the $34,300 which is typical for several schools within the State University of New York system.

Other institutions outranking M.I.T. included Rockefeller University ($41,400); several units of the City University of New York; Johns Hopkins, Rutgers, and the University of Pennsylvania ($36,600); Columbia and Yale ($35,600); California Institute of Technology and Stanford ($35,300); Chicago ($35,100); and the New Jersey Institute of Technology ($34,900).

Cooperation on Teaching Writing

"Writing is the essential skill of an educated person, and recent emphasis upon 'basic skills' should be replaced by attention to improved writing at all levels of ability."

That's the conclusion of representatives of seven major universities — including M.I.T. — meeting last summer to establish long-term cooperation on how to improve the teaching of writing. The result: proposals for a series of research, teaching, and writing projects on the subject, among them schemes to improve the training of writing teachers, to examine new ways of teaching in writing centers, to exchange information on diagnostic and advising procedures, and to explore applications of technology to teaching and learning how to write.

The Alfred P. Sloan Foundation funded the preliminary summer conferences, with representatives from M.I.T., Columbia, Cornell, Harvard, Princeton, Stanford, and Yale.

Teaching Cambridge Teachers

M.I.T.'s Upward Bound, the program to help disadvantaged and minority students toward careers in professions represented at the Institute, has completed the first of three summer programs under its Project STILE (Student/Teacher Interactive Learning Environment).

Twenty Cambridge high school teachers spent most of the summer in a series of intensive workshops at M.I.T., learning to be more effective and interactive in their classrooms. John Terry, Director of Upward Bound, is convinced that "much more powerful techniques for teaching" can be used in many schools, and Project STILE is based on his concepts for "instilling in teachers and children a positive attitude toward each other and the learning atmosphere."

Funded by the Massachusetts Office of Education, Project STILE will follow the progress of its first 20 teachers during the coming academic year and accept additional groups of 20 for training during the summers of 1978 and 1979.

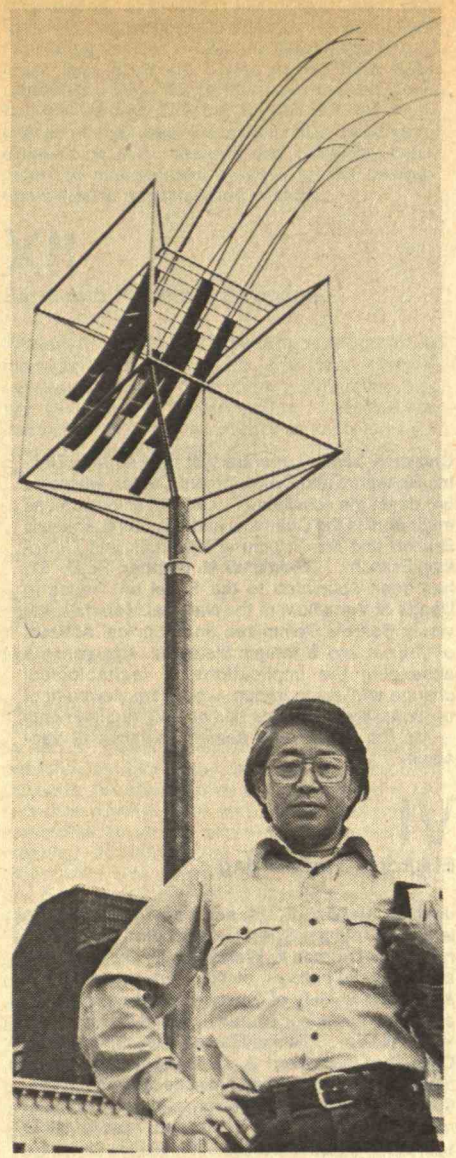
Through the Food Line Only Once

At a time when the cost of almost everything is going up, it's news that the cost of food service under a new option — the "once-through" plan — is coming down at M.I.T. this fall.

Students subscribing to the Lobdell Dining' Room's "once-through" service forfeit the privilege of unlimited seconds which has been a feature of all recent commons meals plans at M.I.T. They pay about 15 per cent less than for "unlimited seconds" — a bargain, thinks H. Eugene Brammer, Director of Housing and Food Services, because he estimates the food savings at only 12 to 12.5 per cent. The "unlimited seconds" plans will still be available for students who want them.

Safety Award

The Award of Honor in its College and University Awards Program came to M.I.T. from the National Safety Council during the summer. It represents a high evaluation of the Institute's safety record against the Council's benchmark safety standards — "a great tribute to the M.I.T. community," says John M. Fresina, Director of the M.I.T. Safety Office.



The structure silhouetted in the sky above Michio Ihara's head is a sculpture which now stands in Central Square, Cambridge. Mr. Ihara is a Fellow in the Center for Advanced Visual Studies at M.I.T., and his sculpture — called "Central Square" — was a gift to the city on the occasion of its Cambridge River Festival last summer. (Photo: Calvin Campbell)

The problem: design and build a structure — using only computer cards and staples — that will support the four-pound weight of a common brick. The joy is recorded by Danita M. Barker of South Hadley, Mass. — hers worked. Ms. Barker was one of 37 high school students who spent two weeks in M.I.T.'s Minority Introduction to Engineering program last summer. The idea was to motivate minority high school students to consider engineering as a career by exposing them to the kinds of problems and rewards associated with eight different engineering fields. (Photo: Calvin Campbell)

No. 2 in Alumni Communications

Four major awards for alumni-related activities came to M.I.T. through the annual national competition of the Council for the Advancement and Support of Education last summer:

☐ An "exceptional achievement" award for the general excellence of its alumni communications programs, placing M.I.T. second in the nation (to Brown University) in this evaluation.

☐ The Grand Award for Direct Mail Programs sponsored by Time, Inc., placing the mailing materials for the 1977 Alumni Fund at the top of the nationwide competition.

There were also awards for direct mail materials prepared in support of the 1977 Technology Day, the fund for the Sailing Pavilion, and the Alumni Fund challenge gift program.

☐ An "exceptional achievement" award for *Technology Review,* placing it among the top four alumni magazines in the nation, and a "visual design in print" award for the cover ("Wind") of *Technology Review*'s January, 1977 issue.

☐ "Visual design in print" citations for the roster of donors to the Sailing Pavilion, an announcement of the Building 10 Fund, and a brochure in support of the Building 10 Fund. These added up to an "exceptional achievement" award — one of 11 made by C.A.S.E. — in the "visual design in print" category.

Graphic design of all the winning publications was the work of Nancy Pokross of M.I.T. Design Services.

J. C. Wei

James Wei Named to Head Chemical Engineering

James C. Wei, Ph.D. '55, who's earned major distinction in the profession of chemical engineering since leaving the Institute with two graduate degrees in that field, will return to M.I.T. on January 1 as Head of the Department of Chemical Engineering.

He'll succeed Kenneth A. Smith, '58, Professor of Chemical Engineering, who has been Acting Head of the Department since the resignation of Professor Raymond F. Baddour, Sc.D. '51, a year ago. Dr. Baddour, on sabbatical last year, returns to full-time teaching and research in the Department this fall as Lammot du Pont Professor.

Dr. Wei has been Allan P. Colburn Professor of Chemical Engineering t the University of Delaware since 1971; his research there has been in catalysis and reaction engineering with applications in emissions control, coal gasification, biological systems, and chemical processing economics. For four months this fall he is Sherman Fairchild Distinguished Scholar of Chemical Engineering at California Institute of Technology.

With Mobil Oil Corp. after completing graduate degrees at M.I.T., Dr. Wei made what is called a "major contribution to the chemical engineering literature" by developing monomolecular theory for the structure and analysis of complex reaction systems; this work became the foundation for Mobil's computer models of refinery processes. By 1970, after attending the Advanced Management Program at Harvard Dr. Wei was Manager of Long-Range Planning for Mobil, where his responsibilities included studies of future energy supply and demand.

Dr. Wei holds the Petroleum Chemistry Award (1966) of the American Chemical Society and the Professional Progress Award (1970) of the A.I.Ch.E.

Dr. Wei first came to M.I.T. for graduate study from Georiga Institute of Technology, where he earned his bachelor's degree in chemical engineering in 1952.

I
Civil Engineering

Shyam D. Sharma, C.E. '62, is currently with Jacobs Engineering Group at Mountainside, N.J., as a project engineer. He recently completed sludge waste treatment projects for Indianapolis Light and Electric Power Co., Petersburg, Ind., and Duquesne Light Co., Phillips Station, South Heights, Penn. He is now working on a uranium extraction plant in East Tampa, Fla. . . . **Thomas S. Maddock,** S.M. '51, has been elected by the Board of Directors of the Institute for the Advancement of Engineering to the lifetime grade of Fellow. Fellowships in I.A.E. are awarded to those individuals who have rendered outstanding service to the advancement of the profession of engineering, and to the public appreciation of it, in the Greater Los Angeles area.

II
Mechanical Engineering

Piper Aircraft Corp. has named **Harry M. Graham,** S.M. '48, as new general manager of the company's Lock Haven, Penn., Division. He has been with the company for two years, but boasts a 28-year career in the aviation industry . . . **Fred Hajjar,** M.S. '77, has joined the General Electric Research and Development Center as a mechanical engineer . . . At the University of Delaware, **David Y. S. Lou,** Sc.D. '63, was promoted to full professor in the department of mechanical and aerospace engineering . . . **N. Richard Dunteman,** S.M. '70, has been promoted to the position of supervisor in the engine design section of the Electro-Motive Division of General Motors. He will be responsible for performance and combustion development engineering in the engine design section . . . **Jan Hult,** Sc.D. '57, has been Professor in Applied Mechanics at Chalmers University, Gothenburg, Sweden, since 1961. He also now holds the office of Secretary-General at the International Union of Theoretical and Applied Mechanics.

III
Materials Science

Henry J. Piehler, Sc.D. '60, has been elected a director of the American Society for Testing and Materials, which is the world's largest source of voluntary consensus standards for materials, products, systems, and services. He has been on the engineering faculty of Carnegie-Mellon University since 1967 . . . **Hans E. Picard,** Sc.D. '67, is currently an independent management consultant to industry in information and communications systems and operations problem-solving . . . **Rodney E. Hanneman,** Ph.D. '61, has been named manager of the newly-created Materials Characterization Laboratory at the General Electric Research and Development Center, where he will direct the activities of nearly 40 scientists and engineers in the Chemical and Structural Analysis Branch and the Structural Materials and Corrosion Branch . . . **Frederick H. Buttner,** Sc.D. '51, has been appointed to the Panel on Trends in Usage of Vanadium of the National Materials Advisory Board's Committee on Technical Aspects of Critical and Strategic Materials. The panel is assessing the implications of technological change and usage trends — from the viewpoint of essential civilian needs and military requirements — on the supply and demand balance of vanadium.

VI
Electrical Engineering

Jack M. Aiello, E.E. '74, has a new position — he is now a Training Specialist with the Intel Corporation . . . **Thomas F. Weiss,** Ph.D. '59, is among the 14 new Fellows elected nationally to the Acoustical Society of America. He is currently an associate professor of electrical and bioengineering at M.I.T. . . . Bunker Ramo Corp., Chatsworth, Calif., has appointed **A. D. Berk,** Sc.D. '54, as president of its space and missile systems operations, engaged in the design and production of nuclear penetration systems and missile cable systems . . . **Pat V. Costa,** S.M. '69, has been appointed Assistant to the General Manager at GCA/Vacuum Industries, a manufacturer of vacuum metals processing furnaces and sputter deposition systems for semiconductor manufacturing . . . **Edward E. David, Jr.,** Sc.D. '47, is currently President of the Exxon Research and Engineering Company, Florham Park, N.J.

David D. Holmes, S.M. '50, has been named Director, Television Research Laboratory, at RCA Laboratories in Princeton, N.J. He has been awarded three RCA Laboratories Outstanding Achievement Awards for his research on color television . . . The University of Colorado at Denver faculty elected **Burton J. Smith,** Sc.D. '72, as its vice chairman for the coming academic year. He is currently an assistant professor of electrical engineering at the school . . . **Stanley I. Kramer,** S.M. '46, has been named Department Head of Reliability/Maintainability at the A.I.L. Division of Cutler-Hammer, Deer Park, N.Y. He will be responsible for the support of all of A.I.L.'s programs and proposal efforts in the areas of Reliability and Maintainability.

George Reichenbacher, S.M. '67, has been promoted to Product Line Manger, Modular Instruments in the Instruments and Systems Group of Analog Devices, Norwood, Mass. In this new position he is responsible for all marketing, product development, and business planning for the company's line of digital panel meters and communications modules . . . **Kenneth R. Stafford,** S.M. '66, has been promoted to Design Manager of Industrial Products, Linear Division, Fairchild Semiconductor, Mountain View, Calif. . . . **Donald**

E. Gorelick, S.M. '73, is currently Vice President, Engineering, at Meditron Instrument Corp., Milford, N.H., where he is developing portable patient monitoring devices . . . Marine Management Systems, Inc., Stamford, Conn., named **Bala Subramaniam,** S.M. '53, to the newly-created position of Resident Director, Europe. He will be in charge of their new European office in London, England. M.M.S. designs and develops computerized management systems for the international marine transportation industry.

XII

Earth and Planetary Sciences

William P. Walsh, Ph.D. '54, has been appointed manager of oceanographic and environmental services at Raytheon Company's Submarine Signal Division, Portsmouth, R.I. . . . **David D. Jackson,** Ph.D. '69, is currently an associate professor of geophysics at U.C.L.A., and is doing research in seismology and earthquake prediction . . . **Peter R. Taro,** Ph.D. '66, retired from the U.S. Navy as a Captain at the end of last year. He is now manager, Ocean Sciences Division, at Science Applications, Inc., McLean, Va.

XV

Management

Ephraim R. McLean, Ph.D. '70, is editor (with John V. Soden) of a new book, *Strategic Planning for M.I.S.* (Management Information Systems), published by John Wiley and Sons, New York. In the book, the editors draw on the expertise of information specialists at major public and private enterprises in order to survey various methods of planning for information systems, particularly those which use computers . . . M.I.T. Press has just published *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the R & D Organization* by **Thomas J. Allen,** Ph.D. '66. The book gives a comprehensive view of the management of technical information and shows how actual information-flow patterns can be utilized to improve communication among technologists . . . **John C. Reid,** S.M. '74, has completed a year's fellowship with the City of Atlanta with a leave of absence from the Coca-Cola Company, as special assistant to the Mayor.

John N. Maguire, S.M. '60, President of Software Ag, has established during the past year business operations for his company in Israel, South Africa, Australia, Brazil, Venezuela, and Japan. This expansion had been planned for some time and was accomplished during 1976-77. . . . **Gary E. Frashier,** S.M. '70, of the Loctite Corporation, Newington, Conn., has been elected to membership in the Young Presidents' Organization, Inc., a worldwide educational association of successful young chief executives who have become presidents of sizable companies before the age of 40 . . . **James J. Grimes,** S.M. '67, has been appointed manager-technical liason in the Electrical Products Division of the Corning Glass Works, Corning, N.Y.

Thomas H. Martzloff, S.M. '49, has been named Senior Vice President and elected to the Board of Directors of Paul Stafford Associates, Ltd., a leading national firm of executive recruiting consultants headquartered in New York City . . . **Frederick E. Mangelsdorf,** S.M. '60, has been elected a member of the Corporation of the Woods Hole Oceanographic Institution . . . **Ronald C. Buehner,** S.M. '62, has been appointed corporate director of management services for Lear Siegler, Inc., Santa Monica, Calif. . . . **Eugene A. Cafiero,** S.M. '60, received an honorary doctor of science degree during commencement exercises at Wittenberg University, Springfield, Ohio, this past June. He is president of the Chrysler Corp. . . . **Stephen E. Winer,** S.M. '65, has joined J.T. Baker Chemical Co., Phillipsburg, N.J., as Manager, Market Development, Fine and Industrial Chemicals. His major efforts will be to develop major new businesses emphasizing proprietary products and/or processes in growth markets.

XVI

Aeronautics and Astronautics

Robert Summers, Sc.D. '54, is now with the U.S. E.R.D.A. . . . **Abner B. Martin,** S.M. '54, is a member of the Air Force/Industry team selected to receive the 1976 Robert J. Collier Trophy for successfully producing and demonstrating the B-1 Strategic Bomber. The Collier Trophy is awarded for the greatest achievement in aeronautics or astronautics in America . . . **Gerald M. Anderson,** S.M. '61, has retired from the U.S. Air Force at Wright-Patterson A.F.B., Ohio, after 20 years of service. During the retirement ceremony, he was presented the Meritorious Service Medal for his outstanding performance as a professor with the department of aeronautics and astronautics, Air Force Institute of Technology, Wright-Patterson . . . **Francis J. Hale,** Sc.D. '63, has been appointed as Visiting Professor of Mechanics for 1977-78 at the U.S. Military Academy . . . **John D. Regenhardt,** S.M. '62, has graduated from the Industrial College of the Armed Forces at Ft. Lesley J. McNair, Washington, D.C. The college provides specialized education in the management of logistics resources for national security, and is one of the nation's highest military educational institutions . . . **Marc L. Sabin,** Sc.D. '73, has graduated from the Armed Forces Staff College at Norfolk, Va. The five-month Department of Defense school provides students with intensive education related to national and international security.

XVIII

Mathematics

Willem V. R. Malkus, Professor of Applied Mathematics, has succeeded Professor **Daniel J. Kleitman** as Chairman of the Committee on Applied Mathematics. He will thus share administrative responsibilities with Professor **Kenneth M. Hoffman** Head of the Department, and Professor **W. Gilbert Strang,** '55, Chairman of the Committee on Pure Mathematics.

Three mathematicians have accepted new faculty appointments:

☐ **William H. DuMouchel,** formerly at the University of California (Berkeley), is now Associate Professor of Applied Mathematics. A graduate of the University of Detroit (S.B. 1965) and Yale (S.M. 1967, M.Phil. 1968, Ph.D. 1971), he's Associate Editor of the *Journal of the American Statistical Association,* formerly a teacher at University College, London, and the University of Michigan.

☐ **Eugene B. Trubowitz,** who completes his doctorate at the Courant Institute this year, will join the Department as Assistant Professor on January 1; his publications are in theoretical mathematics.

☐ **John G. Sclater** has been promoted from Associate Professor of Marine Geophysics to Professor of Mathematics. A native of Edinburgh trained in physics, Professor Sclater has worked in geophysics at the Scripps Institution of Oceanography and — since 1972 — at M.I.T. His degrees are from Edinburgh (B.Sc. 1962) and Cambridge (Ph.D. 1966).

Alfred Clark, Ph.D. '63, received the first Engineering Teaching Award offered by the University of Rochester's College of Engineering and Applied Science. Until recently, he had been chairman of the University's Department of Mechanical and Aerospace Sciences, and he has now returned to full-time teaching and research. The award cited Clark's concern for and interest in students as well as his "completeness as an educator." He has been a member of the University of Rochester faculty since 1964.

Carl I. Wunsch Is Acting Head as Earth and Planetary Committee Begins Search

The task of filling the chair left empty at M.I.T. when Frank Press, formerly Head of the Department of Earth and Planetary Sciences, became Science Adviser to President Jimmy Carter has fallen to Professor Stanley R. Hart, '56, and five colleagues who together constitute a search committee.

Meanwhile, Carl I. Wunsch, '62, Cecil and Ida Green Professor of Physical Oceanography, has been named Acting Head of the Department. His research and teaching are in the field of oceanic circulations — including waves, tides, and mixing processes — for which he's received the Macelwane Award of the American Geophysical Union.

Robert A. Alberty, Dean of Science who named the search committee for Professor Press' successor, says he expects a report in nine to 12 months. Serving with Professor Hart on the committee are Professors Burrell C. Burchfiel, William F. Brace, '46, Peter Molnar, Gordon H. Pettengill, '48, and Sean C. Solomon, Ph.D. '71.

Steele to Direct Woods Hole

John H. Steele, Deputy Director of the Marine Laboratory of the Scotland Department of Agriculture and Fisheries, will become Director of the Woods Hole Oceanographic Institution next October. He'll come from Scotland to succeed Paul M. Fye, who has been Director for nearly 20 years.

Dr. Steele is an expert in the physical and biological processes of the oceans, including marine pollution and environmental quality, and he's been a leader in a number of important international oceanographic experiments.

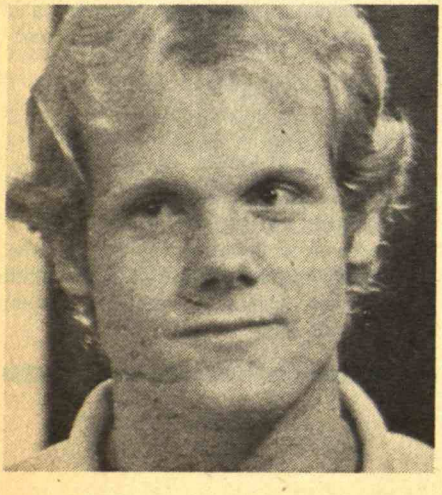
Anyone Interested in Ships?

The Department of Ocean Engineering this spring asked the faculty to recommend eliminating three graduate degrees: Marine Mechanical Engineer, Naval Architect, and Naval Engineer. The faculty concurred, and so, too, did the Corporation at its June meeting.

But not without debate.

"What degree would be appropriate for a person interested in ships?" Professor Ira Dyer, '49, Head of the Department, was asked at the faculty meeting.

His answer: the faculty of the Department and some of its alumni are agreed that the degree of Ocean Engineer is appropriate and sufficient. All four degrees were "almost identical," he said.



If these look like people you'd like to know better, hurry on back to Cambridge. For these are the Class of 1981 —photographs made by Gordon R. Haff, '79, of The Tech *during the first days of the new academic year, as members of the Class were learning about the life they would lead for the next four years and the classmates with whom they would share it.*

Who Are M.I.T. Alumnae?

Older graduates may recall that women students were few and far between when they attended M.I.T. But it may come as a surprise that not until the mid-1960s did women reach the percentage of M.I.T.'s total enrollment they claimed in 1895. Then it was 6 per cent. The Women's Laboratory, established by Ellen Swallow Richards in 1876, broke the way for their admission to any course in the Institute by 1883. The women trained in those early years went on to have notable careers in a variety of fields, and the recovery of their history was the thesis project of Marilynn Arsey Bever, '76.

Her study, reported at a spring meeting of the Association of M.I.T. Alumnae, encompassed the first 70 years of attendance by women from 1871 to 1941 — totaling 1,081 women, 307 of which received degrees. Their preponderent courses of study were chemistry, biology, and architecture.

Many of the women, whether they received an M.I.T. degree or not, went on to have careers. Of the 339 for which Ms. Bever found information on occupation, almost half entered the field of education, with equal distribution among elementary, high school, and collegiate faculty. Twenty-four entered public health fields, 37 became architects, five are practicing artists, 15 writers, and 19 physicians. Most interesting to Ms. Bever, though, was the evidence that 36 women entered occupations that have been traditionally considered "inappropriate" for women. Some of these included: six industrial chemists, four food technologists, three physicists, two aeronautical engineers, two patent attorneys, an electronics corporation executive, and an hydraulic engineer.

Ms. Bever highlighted some of the promninant careers of women who attended M.I.T. before 1923. Besides inaugurating the presence of women in their fields, they were just as often pioneers in their own right.

— *In Education:* The progressive educator **Bessie T. Capen,** Class of 1878, founded Miss Capen's School for Girls in Northampton, Mass. Her educational principles were those which emphasized personal freedom and self-discipline for she believed that many women who later failed in college did so, not from lack of ability, but rather lack of independence due to close supervision. She did away with the conventional study hall, so each girl worked on her own and spent her time as she pleased . . . as long as the work was done. A portrait of Miss Capen by two of her nieces gives a sampling of her convictions: "The usual boarding school of the day was of the 'finishing school' type. She wished a school where all the students should be held to the standards required for college preparation, a working and not a society school. I remember her saying once to a mother who spoke rather snobbishly of the 'working classes,' 'I'm thankful to say that my girls, for the most part, belong to the working class,' and adding with a laugh, 'At the end of the year I mean to get rid of a few that don't.'" . . . **Marcella I. O'Grady Boveri,** Class of 1885, founded the Biology Department at Albertus Magnus College in New Haven, Conn. . . . **Katherine Blunt,** Class of 1903, was President of Connecticut College for Women in New London in 1929 after having been Associate Professor of Food Chemistry and Home Economics at the University of Chicago. . . . **Mary Louise Foster,** Class of 1897, was known for her work in establishing laboratories for women. She was an associate professor of chemistry at Smith College and in the 1920s was appointed the American representative and exchange professor to the University of Madrid, where she organized a chemistry laboratory for women. In 1932 to 1935 a second lab was established for women students, in Santiago, Chile. . . . **Ada May Fitts,** Class of 1896, was Director of Special Education Classes in the Boston Public Schools from 1912 to 1937, a leader in education for retarded children.

— *In Architecture:* The first all-female architectural firm in the United States was headed by **Lois Lilley Howe,** Class of 1890, **Eleanor Manning O'Connor,** Class of 1906, and **Mary Almy,** Class of 1920. Located in Boston, they specialized in the design and restoration of colonial-style houses. Lois Lilley Howe received Second Prize in the Chicago World's Fair competition for women's building. . . . **Elisabeth Coit,** Class of 1919, specializes in public housing. In 1972 she was named Commissioner of the Landmarks Preservation Commission in New York City. . . . **Marion C. Coffin,** Class of 1904, and **Rose Standish Nichols,** Class of 1899, were well-known landscape architects. Miss Coffin designed the grounds at the University of Delaware and in 1930 received the Gold Medal of Honor from the Architectural League of New York.

— *In Medicine:* **Alice B. Bryant,** Class of 1886, was the first woman physician to specialize in the treatment of ear, nose and throat diseases. She wrote over 75 articles in her field and invented medical instruments which are now considered standard in this practice. Dr. Bryant was also a forerunner in the establishment of evening clinics in the Boston area. . . . **Helen Ross Hosmer,** Class of 1906, became the physician for the Grenfell International Mission in Labrador in 1937. Prior to that time she worked as a chemist for General Electric's research laboratory.

— *In Public Service:* **Isabel F. Hymans,** Class of 1888, was noted for her efforts to eradicate tuberculosis as trustee of the Boston Sanitorium and Clerk of the Boston Tuberculosis Association. She also founded the Louisa M. Alcott Club in the South End of Boston which provided social welfare assistance to young people. . . . **Excellenza L. Morse Westby,** Class of 1922, was the first woman to be appointed Chief Examiner of the U.S. Patent Office and was employed there from 1925 to 1955.

The data collected by Ms. Bever is overwhelming but she sees it as only a beginning. She plans to focus on the lives of particular women through interviews and sifting through the boxes of correspondence that have been bequeathed to the M.I.T. Historical Collections. Already the oral histories of five women who attended M.I.T. from 1935 to 1937 have been recorded.

Her statistics have formed a nest for questions. The large attrition of 51 per cent is curious — as many as 133 women failed to complete their fourth year of study. But the rate dropped to 3 per cent in 1930, and was generally low between 1921 and 1940. Perhaps these women were more goal-oriented than their sisters. Ms. Bever thinks that comparisons with data from women's colleges might yield some clues. — *S.F.*

R. M. Solow

Killian Award to Robert M. Solow

"Brilliant and path-breaking" describe the scholarly work of Robert M. Solow, Institute Professor and Professor of Economics, in 27 years as a member of the M.I.T. faculty. And his teaching and research have been accomplished "with such wit, style, and commitment as to give him a special place in our community."

The quotations are from the citation for the 1977-78 James R. Killian, Jr., Faculty Achievement Award made to Professor Solow late last spring. It's an annual prize with a $5,000 stipend to recognize "extraordinary professional accomplishments" by members of the faculty, and the recipients traditionally deliver major lecture or lectures during the year of their award.

Professor Solow is widely regarded as an outstanding economic theorist. His work has focussed in mathematical economic theory, the theory of capital and growth, macroeconomics, and the economics of natural resources; and in all these fields he has made findings "directly relevant to public policy," says the citation. He joined the M.I.T. faculty in 1950 after completing three degrees (B.A. 1947, M.A. 1949, and Ph.D. 1951) at Harvard, and he became Institute Professor upon nomination by the faculty in 1973.

Special Assistant for the Alumni Fund

Ronald S. Stone, '59, Regional Director (West) of the Alumni Association, is now also Special Assistant to the Association's Vice President, in charge of the Alumni Fund.

It's a major — if temporary — responsibility: Mr. Stone is directing all aspects of the 1978 Fund until a permanent Director of the Fund, replacing Frederick G. Lehmann, '51, is appointed. (Mr. Lehmann left M.I.T. last spring to become Director of Development at Boston University.)

Mr. Stone — who will continue to work with alumni in the western states as Regional Director — will be supported in his work on the Alumni Fund by Jacqueline M. Findlay, '44, Assistant Director, Joseph J. Martori, Director for Alumni Services, on class gift programs, and Nancy J. Wheatley, '71, Director of Conferences, on special Alumni Fund projects.

R. C. Seamans, Jr.

Seamans Moves from E.R.D.A. to M.I.T.

After being Secretary of the Air Force, Deputy Administrator of the National Aeronautics and Space Administration, President of the National Academy of Engineering, and Administrator of the Energy Research and Development Administration, what do you do for an encore?

You return to your *alma mater* to become Henry R. Luce Professor of Environment and Public Policy.

"With the many challenging programs here, I wonder why I ever left Cambridge," said Robert C. Seamans, Jr., Sc.D. '51, after announcing in April that he would rejoin the M.I.T. faculty, having given up his federal assignment in E.R.D.A.

Dr. Seamans' association with M.I.T. began when he came for graduate work after completing his undergraduate work at Harvard. From 1941 to 1955 he participated in a number of Institute programs in missile guidance, aerodynamics, and propulsion, and for much of this period he was Director of the Flight Control Laboratory. He joined RCA in 1955, then returned to M.I.T. in 1968 and 1969 as Jerome Clark Hunsaker Professor in the Department of Aeronautics and Astronautics.

As Luce Professor, Dr. Seamans says, his emphasis will be on how to increase the impact of technology on critical national issues. "I look forward to investigating ways to accelerate technology utilization, particularly as applied to energy conservation and production," he says, and he expects M.I.T. classrooms and laboratories will be "an excellent testing ground for such studies."

The Luce Professorship was established in 1973 by the Henry Luce Foundation, Inc., for a member of the faculty focusing on "public policy implications arising from the extraordinary impact that technological advances have had on natural systems."

Publishing Awards

Two citations for outstanding publishing in scientific, technical, and medical books and journals have come from the Association of American Publishers to the M.I.T. Press. In its first annual competition, A.A.P. chose Joseph S. Berliner's *The Innovation Decision in Soviet Industry* as an outstanding book, and *Oppositions: A Journal for Ideas and Criticism in Architecture,* was named outstanding journal of the year.

K. F. Hansen

Nuclear Regulatory Commissioner

Kent F. Hansen, '53, Professor of Nuclear Engineering at M.I.T., has been nominated by President Carter to be a Commissioner of the Nuclear Regulatory Commission, and his Senate confirmation is expected as this issue of the *Review* goes to press. Professor Hansen, who has been a member of the M.I.T. faculty since 1961, will take a leave of absence for his N.R.C. service; he holds a doctorate (Sc.D. 1959) in nuclear engineering from M.I.T. and is widely known for work in reactor safety analysis and fuel management.

Reporting mid-summer confirmation hearings before the Senate Environment and Public Works Committee, the *Wall Street Journal* took some pleasure in noting that Professor Hansen apparently disagrees with the White House policy on deemphasizing breeder reactor research. Professor Hansen was quoted as saying the cancellation of the Clinch River research reactor would be "premature," and that the $1.9-billion plutonium-fueled plant "should be built" because breeder reactors may be important alternative energy sources in the future. Later Professor Hansen told the *Journal* that the White House hadn't asked him what he thought about breeders.

S. J. Keyser

Samuel J. Keyser Appointed to Head Linguistics and Philosophy

Samuel J. Keyser, who was a member of the research staff in the Research Laboratory of Electronics in 1961-62, has returned to the Institute from the University of Massachusetts to be Professor and Head of the Department of Linguistics and Philosophy.

Professor Keyser studied English at Merton College, Oxford, and linguistics at Yale University (M.A. 1960, Ph.D. 1962); he has been head of the Department of Linguistics in Amherst since 1972 and before that taught at Brandeis University. Meanwhile, Professor Keyser has edited the journal *Linguistic Inquiry*, published by the M.I.T. Press, and he's maintained close contact with activities at M.I.T. since he was first here 15 years ago.

Professor Keyser's main research interests are in phonological theory, the history of the English language, and poetics. He succeeds Morris Halle, Ward Professor of Modern Languages and Linguistics, who has been Acting Head since the Department was formed nearly a year ago.

Professor Held Heads Psychology

Richard M. Held, Professor of Experimental Psychology who has been Acting Head of the Department of Psychology since the death early this year of Professor Hans-Lukas Teuber, is now Head of the Department.

Dr. Held joined the M.I.T. faculty in 1963, one year before psychology took its present form as a department in the School of Humanities and Social Science under Professor Teuber's leadership; he has thus shared with Professor Teuber the full period of the Department's development into a major center for studying the origins of behavior, perception, and learning.

Professor Held's own work is on the development of vision and the relationship of vision and behavior. He came to M.I.T. after ten years at Brandeis University, four years at Harvard, and two years at Swarthmore. A graduate of Columbia, where he studied civil engineering (B.S. 1944), Dr. Held holds advanced degrees from Swarthmore (1948) and Harvard (Ph.D. 1952).

Hermann Professorship to London

Dr. Irving M. London, Director of the Harvard-M.I.T. Division of Health Sciences and Technology, is now Grover Hermann Professor of Health Sciences and Technology. He is thus the first occupant of a new chair given to M.I.T. early this year by the Grover Hermann Foundation of Chicago.

Mr. Hermann, President of the Foundation, is retired Chairman of the Board of the Martin Marietta Corp.; he was founder and President of American Marietta Co. prior to its merger with the Martin Co. to become Martin Marietta in 1961. He says he anticipates "an enhanced linkage of current and future technology with developing medical resources" to come from Dr. London's appointment.

At M.I.T. since 1969, Dr. London holds bachelor's (1939) and medical (1943) degrees from Harvard; following World War II service he joined the faculty at Columbia. For 14 years beginning in 1955 Dr. London was Chairman of the Department of Medicine at Albert Einstein College of Medicine and Director of Medical Services at the Bronx Municipal Hospital Center. The Harvard-M.I.T. Division which he now heads is devoted to educating physicians, biomedical scientists, medical engineers, and medical physicists, and to research linking medical science and technology.

Edward N. Lorenz Heads Meteorology

Edward N. Lorenz, Sc.D. '48, who's been studying the circulation of the atmosphere as a member of the Department of Meteorology since 1948, is now Head of the Department of Meteorology. He succeeds Jule G. Charney, Alfred P. Sloan Professor of Meteorology, who wants more time for teaching and research after three years as Department Head.

Professor Lorenz first came to M.I.T. while serving as a weather forecaster with the U.S. Army Air Corps during World War II; he received a Master's degree in 1943, following earlier work in mathematics at Dartmouth (A.B. 1938) and Harvard (A.M. 1940).

His first faculty appointment came in 1956, and since then he's developed important teaching and research activities in the dynamics of atmospheric circulations.

Among his honors are the Symons Memorial Gold Medal of the Royal Meteorological Society (1973) and the Rossby and Meisinger (1963) Awards of the American Meteorological Society.

On leaves of absence he has held teaching and research positions at the Lowell Observatory, the University of California (Los Angeles), the Norwegian Meteorological Institute, and the National Center for Atmospheric Research.

Individuals Noteworthy

Rising and Changing in the World of Business

Robert C. Kyser, Jr., '57, elected a principal of Rath and Strong, a Boston-based management consulting firm with offices also in Chicago and San Francisco . . . **Edward E. David,** Sc.D. '47, opened his own consulting firm, Edward E. David, Inc. in Chicago, Ill. . . . **Theodore L. Thomas,** '47, general manager of Armstrong's Patent Department, elected an assistant secretary of Armstrong Cork Co. . . . **Stephen L. Williams,** '65, named Vice President of Planning at the American Stock Exchange in New York . . . James T. Lawson, '44, former I.B.M. and General Telephone and Electronics executive, named President of EMI Technology, Inc. . . . **Robert B. Nickerson,** '51, materials manager of the Digital Systems Division in Hartford, has been appointed Deputy Managing Director of Veeder-Root Ltd. in Dundee, Scotland.

Counselors: Officers, Directors, Advisors

Alvin G. Waggoner, '42, Vice President of Financial Management and Administration at Cutler-Hammer's AIL Division, has been elected Treasurer of the American Institute of Aeronautics and Astronautics.

Charles A. Zraket, S.M. '53, Senior Vice President of Technical Operations of the MITRE Corp., named Chairman of the Massachusetts Advisory Committee on Computers and Data Processing by Governor Michael S. Dukakis . . . **Gerald P. Cahill,** G.M. '58, former Executive Vice President of the Torin Corp., Torrington, Conn., to President . . . **Frederick Sanders,** Sc.D '54, Professor of Meteorology at M.I.T., elected a councillor of the American Meteorological Society for a three-year term . . . **George Freedman,** '43, Manager of the New Products Center of Raytheon Co.'s Microwave and Power Tube Division in Waltham, Mass., to Chairman of the Board of Governors of the International Microwave Power Institute . . . **Thomas M. St. Clair,** S.M. '58, Comptroller of Koppers Co., Inc., to the Allegheny College board of trustees in Meadville, Penn. . . . **Robert H. Welsh,** '48, Executive Vice President of Ludlow Corp., elected a director of Ludlow.

Norman A. Copeland, '36, a senior vice president of E. I. duPont de Nemours and Co., Inc., Wilmington, Del., to a Fellow of the American Institute of Chemical Engineers . . . **Edward A. Mason,** Ph.D. '51, a member of the U.S. Nuclear Regulatory Commission, to Vice President of Research to Standard Oil Co. (Indiana) . . . **Walter E. Hildick,** '28, Board Chairman of the Curtis and Marble Corp., to Chief Executive Officer and Executive Vice President of Central New England College . . . **Rex M. Ball,** M.A.R. '58, President of HTB, Inc., to membership on the National Municipal League's Governing Council . . . **Robert M. Preer, Jr.,** '65, to Director of Affirmative Action at Massasoit Community College in Brockton, Mass. . . . **Randolph W. King,** N.E. '49, a retired rear admiral, to Executive Director of the Maritime Transportation Research Board of the National Research Council's Commission on Sociotechnical Systems.

Arthur L. Grout, '34, Chairman of the Engineering Graphics Department of the Bridgeport Engineering Institute, to a fellow of the Institute . . . **Daniel B. Grady,** '42, President of Sanfric, Inc., in San Diego, Calif., to President of the Board of Trustees of the San Diego Community College District for 1977 . . . **Francis W. Sargent,** '39, former Massachusetts Governor, to the Board of Overseers of Emerson College in Boston, Mass. . . . **William D. Nordhaus,** Ph.D. '67, Professor of Economics at Yale University, to the President's Council of Economic Advisers . . . **John J. Guarrera,** '43, of the School of Engineering and Computer Science, California State University in Northridge, Calif., to Vice President for Professional Activities of the Institute of Electrical and Electronics Engineers, Inc.

Charles Spangler, '59, Associate Professor, Northern Illinois University, to Chairperson of the Chemistry Department at that school . . . **Edward B. Stringham,** '51, Consultant, The Carborundum Co., to Chairman of the Board of Trustees of Keuka College, Keuka Park, N.Y. . . . **Harl Aldrich,** '47, Haley and Aldrich, Cambridge, to Chairman of a "Committee on the Safety of Dams" for the Assembly of Engineering of the National Research Council . . . **Robert L. Mitchell,** S.M. '47, on the Board of Directors of Celanese Canada and Celanese

Mexicana, to the Board of Directors of the Celanese Corp. . . . **Henry J. Piehler,** '60, Professor of Metallurgy and Materials Science/Engineering and Public Policy, Carnegie-Mellon University, Pittsburgh, to a three-year term as a Director of the American Society for Testing and Materials . . . **Robert L. Sinsheimer,** '41, Chairman, Division of Biology, California Institute of Technology, to Chancellor, University of California at Santa Cruz . . . **Thomas H. Martzloff,** S.M. '49, named Senior Vice President and elected to the Board of Directors of Paul Stafford Associates.

Kenneth A. Roe, '41, President and Chairman, Burns and Roe, to the Board of Trustees of Manhattan College . . . Elected at Woods Hole Oceanographic Institution: **Alan C. Bemis,** '30, to Trustee; and **Frederick E. Mangelsdorf,** S.M. '60, to Member of the Corporation . . . **Richard Jay Bertman,** Principal Architect, Childs, Bertman, Tseckares Associates, Boston, to Massachusetts State Board of Registration of Architects . . . **Robert White,** Sc.D. '49, Administrator, National Oceanic and Atmospheric Administration, to the Board of Overseers of Harvard College . . . **Robert C. Seamans, Jr.,** Sc.D. '42, Henry R. Luce Professor of Environment and Public Policy, M.I.T., to Board of Directors of Combustion Engineering, Stamford . . . **Edwin Hiam,** '48, Foster, Dykema, Cabot and Co., to Secretary of the Boston Museum of Science . . . **Felix J. Conti,** '34, President, T & B Construction, Somerville, to President of the Associated General Contractors of Massachusetts . . . **Peter Samton,** '57, and **Stephen A. Kliment,** '53, to President and Secretary, respectively, of the New York chapter of the American Institute of Architects.

Honors and Awards to the M.I.T. Community

Elected Fellows of the Acoustical Society of America: **Thomas F. Weiss,** Ph.D. '63, Associate Professor of Electrical and Bioengineering; and **Nathaniel Durlach,** Senior Research Scientist, both in the Department of Electrical Engineering and Computer Science . . . To **Stanford Anderson,** Professor of History and Architecture, a Fellowship from the American Council of Learned Societies . . . Elected to ten-year terms on the Board of Trustees of Mount Holyoke College: **Frank S. Jones,** Ford Professor of Urban Affairs; and **Eli Shapiro,** Alfred P. Sloan Professor of Management . . . **J. E. Baldwin,** Professor of Chemistry, elected Waynflete Professor of Chemistry at Oxford University.

The American Society for Engineering Education's highest honor, the Lamme Award, to **Ascher H. Shapiro,** Institute Professor . . . To **Henry Stommel,** Professor of Oceanography, the Maurice Ewing Award of the American Geophysical Union for significant, original contributions to understanding ocean processes . . . An Honor Award from the Boston Society of Architects to Lyndon Associates, founded by **Donlyn Lyndon,** Professor of Architecture. The Award cited the Pembroke Dormitories at Brown University, for which Professor Lyndon was principal designer, as "an exceedingly competent site plan." . . . To **Jay W. Forrester,** Professor of Management, the Harry Goode Memorial Award of the American Federation of Information Processing Societies.

Kudos: Honors, Awards, Citations

John A. van Raalte, '59, an R.C.A. scientist, elected a Fellow of the Society for Information Display . . . **James R. Lackner,** '70, Chairman of the Brandeis Psychology Department, appointed the Meshulam and Judith Riklis Associate Professor of Behavioral Science . . . **Dean S. Shupe,** '69, Associate Professor of Mechanical Engineering, University of Cincinnati, selected by The Ohio Society of Professional Engineers as the outstanding engineering educator of the year for the State of Ohio . . . **William J. Cavanaugh,** '51, elected President of the National Council of Acoustical Consultants . . . **Gary E. Frashier,** S.M. '70, President, Loctite Corp., elected to membership in the Young Presidents' Organization . . . Elected to membership in the American Academy of Arts and Sciences: **Wilbur Bayley Davenport, Jr.,** Sc.D. '43, Professor of Electrical Engineering, M.I.T.; **Courtland Davis Perkins,** S.M. '41, President, National Academy of Engineering; and **Nathan Sivin,** '52, Professor of the History of Science and of Chinese Culture, M.I.T.

To **Haskell R. Gordon,** '38, Worcester businessman and civic leader, an honorary doctorate degree from Worcester State College . . . To **Howard C. Barnes,** '60, Vice President of Charles T. Main Corp., the honorary degree of Doctor of Engineering from Rose-Hulman Institute of Technology . . . To **Eugene A. Cafiero,** S.M. '60, President, Chrysler Corp., an honorary Doctor of Science degree from Wittenberg University, Springfield, Ohio . . . To **Elias James Corey,** '48, Professor of Chemistry, Harvard University, an honorary Doctor of Science degree from Colby College, Waterville, Maine . . . To **Charles Smith Carter,** '28, an honorary Doctor of Laws degree from Concordia University, Montreal.

To **Edward Woll,** '35, Vice President and General Manager of the Group Engineering Division of General Electric Co., the Air Breathing Propulsion Award . . . To **Joseph C. Runkle,** '71, Ph.D. candidate in Metallurgy, M.I.T., the Falih N. Darmara Materials Achievement Award . . . To **Ross B. Corotis,** '67, Associate Professor of Civil Engineering, Northwestern University's Technological Institute at Evanston, the "Tech Teaching Award" from that institute — $1,000 and a certificate . . . To Rear Admiral **W. E. Meyer,** '47, A.E.G.I.S. Project Manager, the Gold Medal Award of the American Society of Naval Engineers . . . To **Ken Fertig,** '50, Chief Scientist, Charles Stark Draper Laboratories, the Thomas L.

Thurtow Award of The Institute of Navigation . . . To **Donald W. Shive,** Ph.D. '69, Chemistry Faculty Member, Muhlenberg College, Allentown, the Lindback Award for "distinguished teaching" at that school.

To **Robert B. Newman,** M.Ar. '49, Vice President, Bolt Beranek and Newman, a Quarter-Century Citation from the Building Research Advisory Board of the National Research Council for his "significant and lasting contribution to the state-of-the-art of building science and construction technology." . . . To **John M. Gray,** '10, the "Executive of the Year" award from the Boston Chapter of the National Association of Women in Construction . . . To **David R. Wheeler,** Ph.D. '74, Assistant Professor of Economics and African Studies at Boston University, the Metcalf Award of $1,000, one of that university's highest awards for excellence in teaching . . . To **John Gowdy,** '67, Professor, Electrical and Computer Engineering, Clemson University, the McQueen Quattlebaum Engineering Faculty Achievement Award at that school . . . To **Alfred Clark,** Ph.D. '63, Professor and Chairman, University of Rochester Department of Mechanical and Aerospace Sciences, the first Engineering Teaching Award offered by that University's College of Engineering and Applied Science.

On Our Bookshelf

By **Robert C. Reid,** Sc.D. '54, John M. Prausnitz, and the late **Thomas K. Sherwood,** '24, formerly Professor of Chemical Engineering, *Properties of Gases and Liquids,* McGraw-Hill . . . edited by **Richard J. Wurtman** and **Judith J. Wurtman,** Department of Nutrition and Food Science, *Nutrition and the Brain,* Raven Press . . . edited by **Robert M. Suskind,** Associate Professor of Pediatrics and Clinical Nutrition, *Malnutrition and the Immune Response,* Raven Press.

M.I.T. Appointments

Robert E. Gorman, Jr., to be New York Area District Officer for the Leadership Campaign, assisting James N. Phinney, New York District Director. . . . Dr. **Michael A. Kane** to be Assistant Medical Director responsible for ambulatory care. . . . **Nelson C. Lees,** '53, Director of Resource Planning, is now also Executive Director of Resource Development. . . . Dr. **Warren Point,** formerly Assistant Medical Director, to Associate Medical Director with responsibility for the Department's programs in education and its professional standards. . . . Dr. **Samuel Stein,** Assistant Medical Director, to be also Director of the M.I.T. Infirmary. . . . **Philip A. Trussell,** '56, formerly Project Director for Cabot, Cabot and Forbes, to M.I.T.'s Investment Real Estate Officer. . . . **Seichi Tsutsumi,** formerly with Jarrell-Ash, Fisher Scientific Co., Waltham, to be Industrial Liaison Officer working with British companies which are members of the I.L.P.

J. H. Keenan

Joseph H. Keenan, 1900-1977: Major Figure in Modern Thermodynamics

Professor Joseph H. Keenan, '22, whose tabulations of the thermodynamics of steam, air, and gas are fixtures of every heat engineer's desk, died on July 17 at Mt. Auburn Hospital a few hours after being stricken at his home in Belmont. He was 76.

Professor Keenan, who had been a member of the M.I.T. faculty since 1934 and Professor of Mechanical Engineering since 1939, retired in 1966. But he staunchly maintained an active life, including both teaching and consulting — even while battling lung cancer for the last three years; only two years ago he traveled to Iran to lecture on thermodynamics. A resolution of his faculty colleagues in the Department of Mechanical Engineering described Professor Keenan as "a master teacher with a highly individual style" and said his work in thermodynamics "changed the face" of university teaching in that field. "He developed a coherent and logical exposition of the fundamentals of thermodynamics so that the widest possible range of problems could be considered in a uniform and consistent manner . . . an uncompromising search for understanding and the elimination of ambiguities overlooked or accepted by others."

After graduation from M.I.T., Professor Keenan spent six years with General Electric Co., then taught at Stevens Institute of Technology until he returned to M.I.T. as Associate Professor in the Department of Mechanical Engineering. Soon thereafter he published *Thermodynamic Properties of Steam,* which has had more than 50 printings as a principal guide in the design of equipment throughout the steam power industry. A decade later came his *Gas Tables,* written with Professor Joseph Kaye, '34, now a basic reference in the design of compression and expansion equipment. His textbook on *Thermodynamics,* published in 1941, has had continuing and widening influence on teaching its subject in all fields of engineering. In the 1960s came important contributions to a new, unifying formulation of thermodynamics in *Principles of General Thermodynamics.*

When Professor Keenan received an honorary doctor's degree from the Univer-

sity of Glasgow in 1966, James R. Killian, Jr., then Chairman of the M.I.T. Corporation, described him as "one of the finest examples I know of a scholar of the first order who is also unremittingly interested in and concerned with the art of teaching."

Professor Keenan was an Honorary Member of the American Society of Mechanical Engineers and held its Worcester Reed Warner Medal (1955).

A memorial fund has been established at M.I.T. as the Keenan Endowment Fund, and contributions may be sent to the Alumni Fund or to Professor Herbert H. Richardson, '53, Head of the Department of Mechanical Engineering.

M. B. Leggett

M. Bryce Leggett, 1917-1977

Ever since he joined the Admissions Office in 1955 as Associate Director, M. Bryce Leggett, S.M. '40, has been its watchdog for details; he has also had major responsibility for transfer and special students.

Mr. Leggett died suddenly at his home in Lynnfield, Mass., on August 13; he was 60.

Having studied chemistry at Harvard (A.B. 1940) and chemical engineering at M.I.T., Mr. Leggett went to work in 1945 with the Sterling Textile Co. in his native Springfield, Mass.; he was a Research Associate and Teaching Fellow at M.I.T. from 1940 until then. After a decade as Treasurer of that company he rejoined the Institute to work in admissions, and he was also Executive Secretary for the Atoms for Peace Awards, Inc., an organization established to honor contributions to the peaceful uses of atomic energy.

In addition, for five years beginning in 1963 Mr. Leggett served as Executive Officer of the faculty Committee on Academic Performance, advising the faculty on matters of scholastic standards, examinations, grading, and the academic performance of undergraduates.

A memorial fund for the benefit of transfer students has been established in Mr. Leggett's name, and contributions may be sent to the Alumni Fund or to the Treasurer's Office at M.I.T.

Joseph F. Lynch, 1922-1977

Joseph F. Lynch, who came to M.I.T. as a porter in the housing system in 1950 and rose through the ranks to become Assistant Director of the Housing Office in 1973, died on June 9 following a brief illness. He was 55.

Mr. Lynch held an associate degree in biology from Boston University, and he came to M.I.T. from the Somerset Hotel following World War II service. During his M.I.T. career he was Manager of Burton House (1965-69), Personnel Counselor in the Personnel Office (1969-71), and Manager for Burton and MacGregor Houses (1971-73).

Allan J. Urquhart, 1922-1977

Allan J. Urquhart, Benefits Officer in the Office of Personnel Relations, died on July 5 following a heart attack.

At M.I.T. since 1969, he was responsible for a wide-ranging benefits program including pension plans, annuities, health plans, scholarships, and pre-retirement planning. Earlier, following study at McGill University and Springfield College (B.A. 1948), he was employed in the insurance industry.

Mr. Urquhart played tennis on the Canadian Junior Davis Cup Team before World War II, and he remained an avid tennis enthusiast. A memorial fund is designated to provide a scoreboard for M.I.T.'s outdoor tennis courts; contributions may be sent to Winifred McDonough, Assistant Recording Secretary of M.I.T., at Room 4-113.

Peter G. Bronchuk, 1929-1977

Peter G. Bronchuk, Assistant Accounting Officer in the Office of the Comptroller, died in Arlington, Mass., on August 1; he was 48.

Mr. Bronchuk, who studied business administration at Northeastern University, came to M.I.T. 12 years ago; he had served in the U.S. Air Force from 1946 to 1949 as aerial photographer and had made a number of flights over the Arctic Circle.

Deceased

Philip H. Chase, '09; July 4, 1977; 221 Thomas Wynne Apts., Wynnewood, Penn.
George C. Kenney, '11; August 8, 1977; 10180 W. Bay Harbor Dr., Bay Harbor Islands, Fla.
John A. Gann, '13; September 14, 1976; 630 S.W. 6th St., Apt. #1, Pompano Beach, Fla.
Lyman S. Baird, '14; November 6, 1976; Rancho Bernando, 16627 Roca Dr., San Diego, Calif.
George P. Elliott, '15; May 14, 1977; 3 Winkley St., Amesbury, Mass.
George W. Simons, Jr., '15; July 8, 1977; 1452 Avondale Ave., Jacksonville, Fla.
Lucas E. Schoonmaker, '17; June 24, 1977; 800 S.W. 25th Place, Gainesville, Fla.
James J. Storrow, '17; July 3, 1977; 14 Harbor Ave., Marblehead, Mass.
Roy C. Sylvander, '17; November 4, 1976; 162 Linden St., Ridgewood, N.J.
Louis A. Brown, Jr., '19; November 15, 1975; 450 N. Rossmore Ave., Los Angeles, Calif.
Russell Hamilton, '19; July 1, 1975
Herbert G. Fales, '20; July 20, 1977; 2201 No. Central Ave., Phoenix, Ariz.
Edward W. Booth, '21; July 14, 1977; 261

N.E. 2nd St., Boca Raton, Fla.
A. Ilsley Bradley, '21; March 2, 1977; 2300 Overlook Rd., Cleveland, Ohio.
Edward S. Dennison, '21; June 11, 1977; 10 Lloyd Rd., Waterford, Conn.
William H. F. Rose, Jr., '21; May 26, 1977; R.D. 2, 111 N. River Rd., Woodstock, Vt.
William H. L. James, '22; May 30, 1977; 1708 E. Rosewood Ave., Anaheim, Calif.
Joseph H. Keenan, '22; July 17, 1977; 11 Howells Rd., Belmont, Mass.
Eliphalet N. Read, '22; June 10, 1977, 6905 Maple Ave., Chevy Chase, Md.
Charles W. Tyson, '22; July 13, 1977; 1119 Calle Catalina, Sante Fe, N.M.
Gerald M. Frank, '23; September 3, 1976; Mellon Bank, Bx. 656, Attn. F. F. Lemmon, Pittsburgh, Penn.
Cecil H. Hubbard, '23; May 9, 1977; 123 Hamlet Hills Dr., Apt. 45, Chagrin Falls, Ohio.
Ralph C. Lockwood, '23; June 15, 1977; 78 Buckingham Club, Sarasota, Fla.
Gilbert T. Loveridge, '25; June 8, 1977; East Poultney, Vt.
Edward O. Murphy, '25; June 18, 1977; 18 Thornewood Rd., Armonk, N.J.
John A. Adams, '27; February 7, 1976; 7625 S.W. Copel Rd., Portland, Ore.
George C. Houston, '27, July 23, 1977; 124 Bay View St., Camden, Maine.
Max L. Libman, '27; August 19, 1976; 1605 Greenbriar Ct., Reston, Va.
James A. Allan, '28; July 4, 1977; 4801 Connecticut Ave., N.W., Apt. 319B, Washington, D.C.
Henry B. Dean, '28, February 2, 1977; 6560 Little Falls Dr., San Jose, Calif.
Percy E. Harvey, '28; February 12, 1976; 2223 Euclid Ave., So., Clearwater, Fla.
Kenneth G. MacCart, '28; February 19, 1976.
Tirso N. Santon, Jr., '28; April 26, 1977; 135 Washington St., Brighton, Mass.
Frederick B. Danner, '29; March, 1977; Prospect St., P.O. Box 769, Litchfield, Conn.
Robert E. Bannon, '30; November 13, 1976; 5 Besler Ave., Cranford, N.J.
William O. Lindbeck, '30; September 5, 1972.
Mitchel Barr, '31; November 20, 1975, Box 2669, Orlando, Fla.
Ralph H. Davis, '31; June 27, 1977; 74 North St., Lexington, Mass.
John M. Ness, '31; May 38, 1977; 79 Fairview Ave., Augusta, Maine.
John L. Turner, '31; July 12, 1977; 1628 Douglass Dr., Jackson, Miss.
George T. E. Sheldon, '32; November 30, 1975; 38 Outer Dr., Oak Ridge, Tenn.
Levi S. Brown, '33; February 8, 1977; P.O. Box 94, Araphoe, N.C.
Glen P. Woodbury, '34; July 14, 1977; 40 Howard St., Reading, Mass.
R. Donald Purcell, '35; March 21, 1977; 10504 Lincoln Dr., Huntington Woods, Mich.
Donald J. Bringardner, '39; May 26, 1976; 229 Quay Assisi, New Smyrna Beach, Fla.
Franklin M. Spooner, '39; June 17, 1977; 2245 Woodland Terr., Scotch Plains, N.J.
Charles H. Markham, '40; May 8, 1977; 234 N. Hewlett Ave., Merrick, N.Y.
Monroe R. Brown, '42; June 25, 1977; Strawberry Banks, Hampton, Va.
Alexander J. Hoffmeister, '46; December 13, 1976; 265 Penhurst Dr., Pittsburgh, Penn.
Frank W. Barry, '47; July 9, 1977; 23 Diana Ln., Windsor, Conn.
Paul G. MacNeill, '47; February 4, 1977; 100 Wellwood Dr., Fayetteville, N.Y.
John H. Anson, '50; June 19, 1977; 2412 Catherine Rd., Altadena, Calif.
Warren M. Cheek, '50; July 5, 1977; 4430 Ortega Forest Dr., Jacksonville, Fla.
Charles J. Henry, '51; September 30, 1974; St. Augustine's Seminary, Bay, St. Louis, Mo.
Alfred R. Paashaus, '51; January, 1977; 221 E. Madison Ave., Collingswood, N.J.
John F. Belford, '52; October 3, 1975; 39 Highland Rd., Westport, Conn.
William A. Hey, '52; July 13, 1977; 1163 Irene Place N.E. Winslow, Bainbridge Isle, Wash.
Fred E. Buchanan, '55; June 22, 1977; 1000 Valley Forge Cir., King of Prussia, Penn.
Charles Benton, Jr., '57; November 29, 1976; 163 Island Creek Dr., Vero Beach, Fla.
Anton Vittone, Jr., '57; July 6, 1977; 840 Shullo Dr., Akron, Ohio.
Thomas J. Lageman, '62; May 22, 1977; 1415 Begonia Dr., Carpinteria, Calif.
John A. Memley, '65; August 25, 1976; 20091 McKinley Ln., Huntington Beach, Calif.

The TURN.SQUARE procedure defined previously turns the turtle before drawing a square, so it can be used to draw each frame. In between frames, the command WIPE can be used to remove the previous frame's picture from the screen.

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TO SQUARE.MOVIE
REPEAT.FOREVER TURN.SQUARE WIPE
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Of course, the movie produced by this simple example is not very exciting by itself. The important point is that the method of creating animation by procedures enables an animator to build up complex movies by starting with a very simple set of facilities and gradually extending it.

Reaching for Realism

Computer animation was not always this easy. When in the early 1960s Ken Knowlton, a computer graphics specialist at Bell Labs, and others started making computer films of crystal growth and orbiting satellites, they were forced to program at a much cruder level. Instead of being able to define objects, give them scripts and then sitting back to watch the result (*see box, p. 40*), they had to think in terms of hundreds of lines that were defined by the x and y coordinates of their end points. Many of these numbers had to be changed every frame to produce movement.

Computer graphics researchers soon developed complex packages of programs that would take the description of an object in terms of its vertices and then apply mathematical functions to create new descriptions that corresponded to the same shape but in a new location, orientation, or size. They next extended their programs so that objects could be defined in three dimensions by their x, y and z coordinates, and these objects could be drawn in perspective from any viewpoint. This projection of three-dimensional objects to a plane is accomplished using techniques of linear algebra and knowledge of simple optics.

The objects in these drawings and films looked like wire frame models. Many researchers, especially a large group at the University of Utah led by Ivan Sutherland, now director of computer science at Cal Tech, began striving for photographic realism. They first worked on the problems of drawing only those lines that should be seen, not those that should be hidden by obscuring surfaces. Still they were dissatisfied with the restriction of these early three-dimensional systems to objects with flat surfaces; they wanted curved surfaces. They programmed sophisticated smoothing techniques so that any shape could be displayed, not just those built from many small blocks.

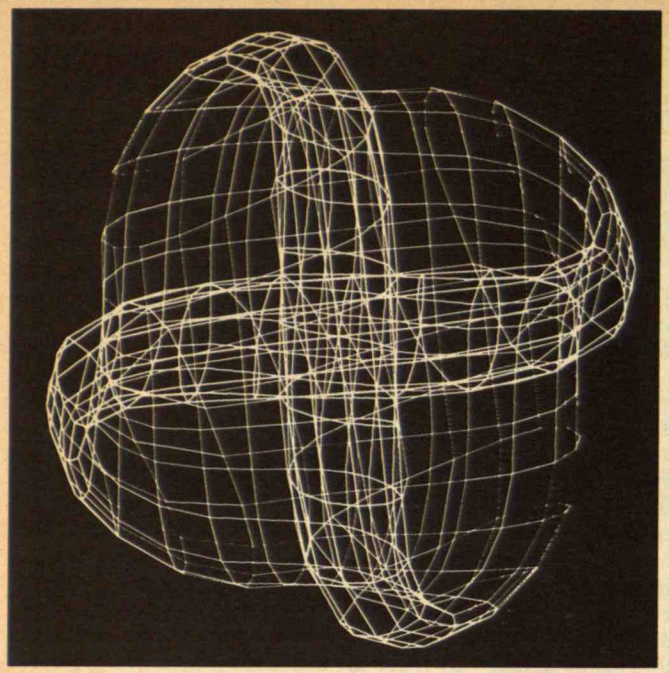
A real object looks very different depending on the number and position of the light sources. Shadows look very different or even disappear with some lighting configurations. Since their system did not have this ability they began working on the problems of simulating the lighting in order to achieve even greater realism. The properties of light, such as its propagation and reflectance, needed to be taken into account for the program to determine how it would appear if light traveled from the light sources, bounced off the surface of the desired objects, and traveled to the program's "viewpoint." The computation of the effects of light bouncing off the objects lead to research on how to describe and simulate different surface textures. In the space of about ten years they repeated the history of attempts to create realism in art from the beginning of the Renaissance to the 19th century. The use of perspective, the attention to light and shadow, recession, and the realistic use of texture and color were rediscovered in the context of computer graphics (*see p. 42*).

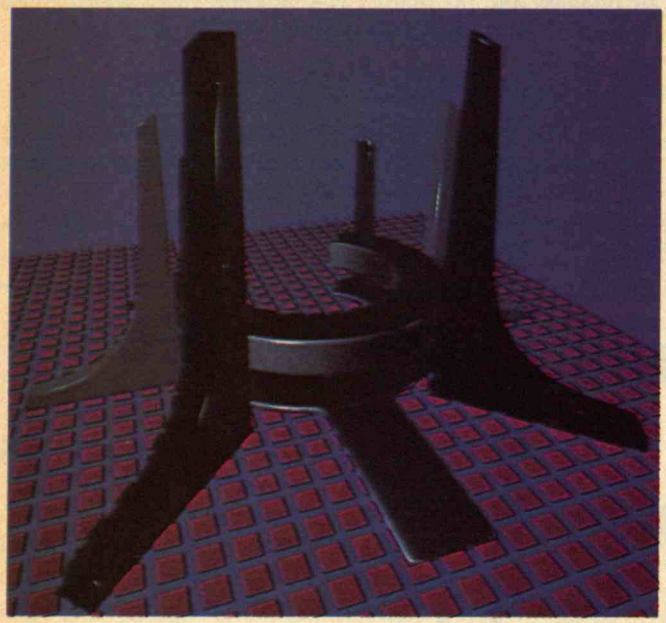
Though a three-dimensional system is often best for instructional and scientific films, there is quite a high price one must pay for such realism. Besides the need for bigger and faster computers to do the enormous amount of computation necessary to produce a single drawing, the burden on the animator is greater. He has the enormous difficulty of describing a complex, curved, shaded three-dimensional object to the computer. Numbers upon numbers are needed and are often obtained in a very tedious fashion. Due to the high computational cost of realistic imagery and the many cases where realism is either not necessary or even desirable, demonstrative and procedural approaches are still being explored.

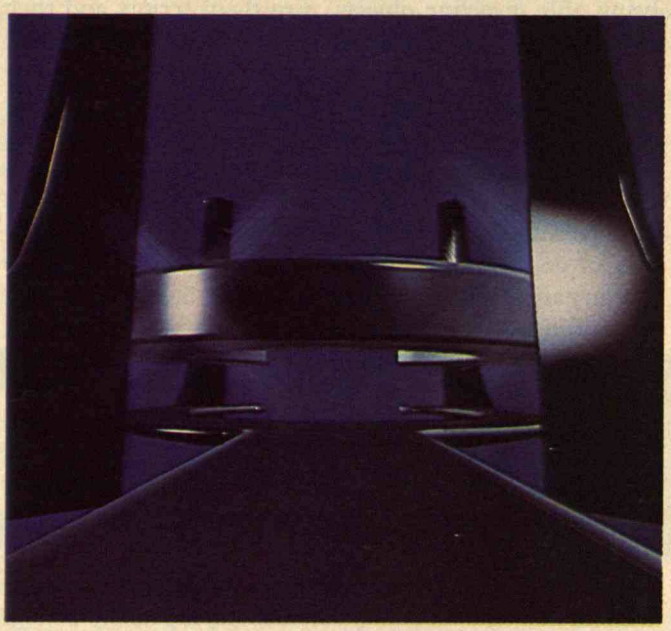
Demonstrative systems are best suited to making animation that is most similar to that animation now being produced completely by hand. They have the advantages that with no training or understanding of computer programming anybody can sit down and quickly learn to use them. The available capabilities are limited, however, by the decisions of the programmers of the system. For example, if one wanted certain effects that were not anticipated by the programmers of the system, such as moving along a perfect circle, or having the motions affected by gravity, or to have the ability to explode objects, then the user must convince an expert programmer to add these abilities to the system. An alternative is to create procedural systems that are easy enough for naïve users to program. As a result they have none of the limitations of demonstrative systems but do require of the user some understanding of programming. That is why languages like Logo are designed to be as easy to learn and use and still retain the generality and flexibility of procedures. While the procedural systems require some mental skills of the user, the demonstrative systems demand the manual skills of artistic drawing. For example, Logo is being used by severely handicapped people who have no control of their hands to produce computer graphics while demonstrative systems would clearly be useless to them.

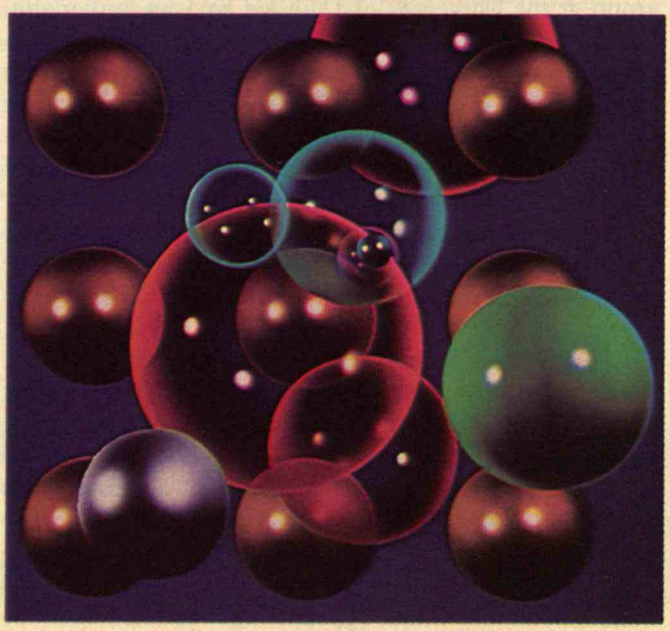
Flavors of Graphics Hardware

For a computer to generate a drawing at least two things are needed — a device to produce the drawing and a way of communicating with that device. In the past, drawings were produced mostly by plotters which draw upon paper with a mechanical pen. Now various sorts of electronic displays are more common. Some displays, called "vector displays" are similar to oscilloscopes and draw lines on the screen. Others are like television sets and "digitize" the screen into a very large number of dots and are called "raster displays." While vector displays usually are faster





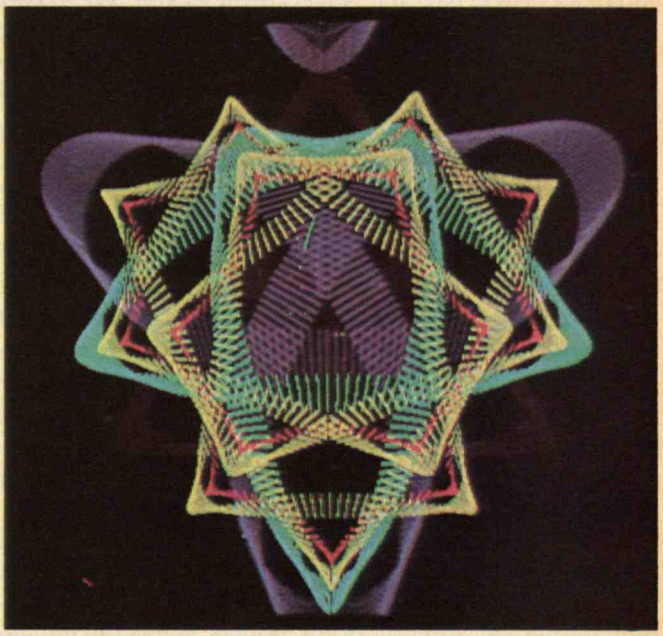


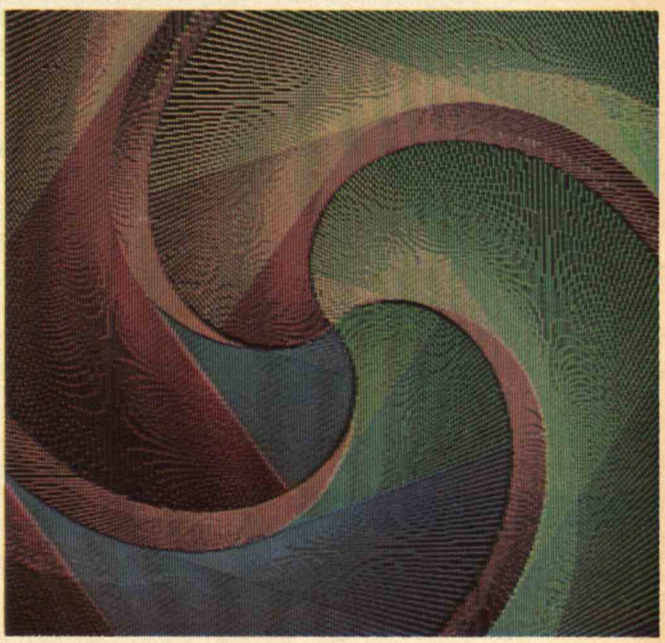


(*Page opposite*) Life-like realism is a recent development in computer graphics. The earliest attempts at achieving three-dimensionality utilized wire-frame models (upper left), requiring computation of an enormous number of points. As the technique becomes more sophisticated, a representation of the object is produced which is comprised of flat planes like the surfaces of a diamond. These planes are later softened through a program which "sands down" the edges. Calculations of distance and orientation with respect to light sources adds shadow and reflection.

The description of images mathematically has an obvious use for the illustration of mathematical concepts. Nelson Max, a mathematician at Case Western Reserve University, gave insight into the abstract process of a sphere being turned inside-out in a film produced from his data at the University of Utah. The figure at the upper right shows an intermediate stage in this process; the inside of the sphere is blue, the outside red. (photos: Jim Blinn, University of Utah; Information International, Inc.)

(*At right*) Abstract films with changing geometric shapes and patterns have grown from collaborations between artists and computer scientists. Simple programs have been transformed into beautiful designs. In the top picture, the transitional images from the extrapolation between the shapes of a circle and a star were overlayed against a checkered background to create a composite image. If portrayed in motion it would represent hundreds of frames of animation. (Photos: Kenneth Kahn, Bonnie Dalzell and Henry Lieberman)

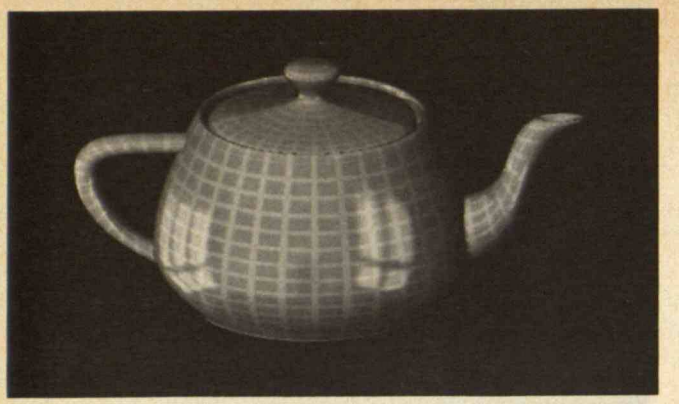




and cheaper, raster-scan displays are better suited for displaying solid or textured regions, colors and characters in various fonts. The computer communicates with these two kinds of displays in different ways. A vector display continuously draws the lines described in a list that is maintained by the computer program. The computer changes the image on the screen by changing that list of lines in its memory. For a computer to control a raster display a section of its memory must be set aside to remember the color of a large number of points, typically a quarter of a million. This section of memory is continually being scanned and converted into an analog television signal that can be seen on almost any television set.

So far, the computer animation described is based upon *digital* computers. It is also possible to produce films using *analog* computers. These systems are extremely fast and are much better suited for transforming images of the world from a television camera. Digital systems, in contrast, almost always synthesize their images. But analog systems are not as flexible as the digital system. To write or change the equivalent of the program in analog computers one has to rewire it as opposed to digital computers where one need only type a few instructions to change a program. A group of researchers at the University of Illinois, Chicago Circle Campus, are trying to get the best of both worlds by creating a hybrid system. They have a digital computer that generates images and motions when needed but it also controls an analog computer that can operate very fast and combine real world images. For example, one can have a computer generated dog run on a photographic beach.

Usually a computer system cannot produce several complex images in a second and so the images need to be recorded in some manner so that they can be replayed at a sufficient speed to create the illusion of continuous motion. This recording is typically done onto movie film, though occasionally onto video tape or disk. Regardless of the medium the procedure is to have the computer gen-



The glazed surface of the teapot was created by stretching a two-dimensional checked-pattern with an algorithm invented to draw curved surfaces accurately by Ed Catmull at the University of Utah. A map of the intensity of light in a simulated room was used to portray the reflection of doors and windows upon the surface. (Photo: Jim Blinn, University of Utah)

erate an image, record it, generate the next image, record and so on. When finished it is played back at many frames per second creating the illusion of motion. Some films consist of images that each took several minutes to generate, so that a few minutes of film might take a few days to record, though several hours is more typical.

Make Your Own Movies

The progress that has been made in computer animation over the past 15 years merely intimates the artistic and recreational possibilities which will be available to the computer specialist and non-initiate alike. Hybrid systems will be created that combine the naturalness of demonstrative systems, the realism and sense of depth of three-dimensional systems, and the versatility of procedural systems. One might even imagine the integration of some analog systems to gain speed and the skill of manipulating real world images.

Computers have been getting cheaper, faster and more versatile every year. If current trends continue, computers will within ten years be cheap enough for nearly anyone to own one. With faster computers and displays the need to film the display in order to see one's animation will disappear. Video disk recorders which are now very expensive will replace film as the medium of recording computer graphics. The quality is potentially better and the animator will be able to play back the results immediately. With the expected production of faster and cheaper computer memories it will be possible to raise the number of permissible colors and the overall quality of the image.

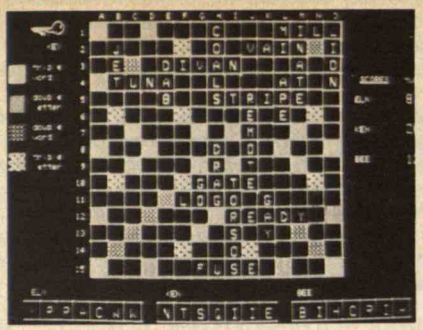
Currently both computer and hand-made animation is too expensive and time consuming to allow one to really explore. It is rare that an animated film goes through many revisions as a result of producing "rough drafts" and then making improvements. Highly responsive computer animation systems will allow one to modify and control the animation as it is being displayed. Currently, this is possible only with very simple imagery, but even with existing machinery it is exciting to be able to watch, say, a rectangle growing and flowing on a screen responding almost instantly to your every command.

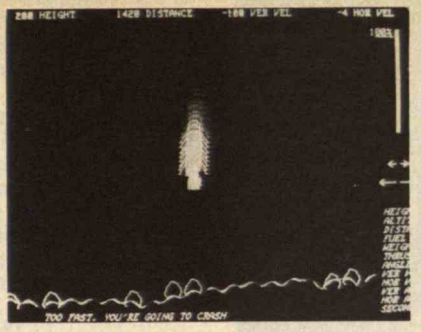
These advances will enable what Nicholas Negroponte, an M.I.T. Professor of Architecture, calls "the return of the Sunday painter." He speculates that cheaper and better systems will turn computer animation into a popular pastime. Instead of watching TV on Sunday afternoon, people will be able to create their own TV shows of a sort not now ever seen. If, as many expect, video disk players and wall TVs are to be common household appliances of the not-very-distant future then people may program kinetic "wall paper" to produce beautiful landcapes or color abstract images to suit their moods. Mini-worlds, full of characters, objects and backgrounds may be marketed for entertainment. Interactive movies may become common where a viewer with a short instruction to the computer can influence the predetermined decision points of the story. One could see the futuristic equivalent of Bambi and be able to decide whether his mother gets killed or not and see the consequences.

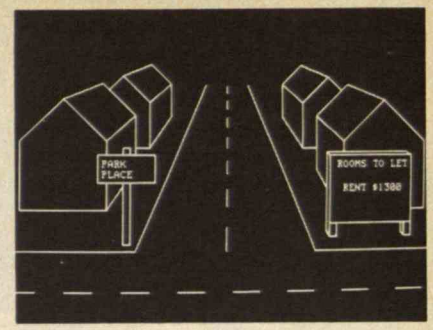
Another direction which computer animation is likely to go is towards "digitized live action." The digital computer is beginning to be used to process real images of the world. These images are fed into the computer via a TV camera and are converted to millions of different colored dots that correspond to the picture. The Viking pictures of Mars were processed by a computer in this way. Once inside the computer in this form, the programmer is then free to manipulate these images in a variety of ways. This sort of animation is most analogous to what animators call "roto-scoping," in which each drawing is based on a frame of live action footage. This has been done since the early 1920s, when, for example, to create realistic movements for Snow White, Disney filmed actors doing the motions needed in the cartoon. As this technique is applied to computer animation one can imagine filming, say, a dance and then after the computer has digitized the film, the dance can be recreated with any choice of colors and textures. Re-drawn characters or abstract shapes could be substituted which would mimic the movements of the dancers.

Researchers at Case Western Reserve are exploring the opposite technique. Instead of filming the world and then cartoonizing it, they are trying to create computerized cartoon characters that appear to be real actors! The computer would generate realistic images of people capable of moving their mouths in synchronization with the voice and of expressing emotions by facial and body movements. The current state of these techniques can be seen in Hollywood movie "Future World" which flourishes a computer-generated likeness of Peter Fonda (*see page 46*). Many a director probably looks forward to the day when he or she can create any character imaginable and have it perform whatever is desired obediently and tirelessly.

Computer systems may be designed to know about animation and the elements being animated. Recent advances in artificial intelligence at M.I.T. provide computational mechanisms that could be used to create a system that is knowledgeable enough about animation to allow the user to interact with the computer at a more conceptual level. For example, the user might simply indicate







Computer graphics can add new dimensions to conventional games such as *Scrabble* (left) or *Monopoly*, in which players drive through a cartoonized Atlantic City (right). But most exciting is the invention of games specially suited to computer animation. *Lunar Lander* (center) tests one's skill in landing a lunar module on the surface of the moon.

Computer Games: Missiles, Mazes and Mountains on the Moon

In the limitless late night hours, when unofficial use of computers is common, computer games are being invented by programming addicts and embellished by other computer freaks across the country. Animation is essential to many of these games, whose images must transform on a display screen as the players make their "moves."

Most exciting is the invention of computer games which would be impossible without the help of a computer. The great-grandaddy of these is *Space War*, invented in the early 1960s by M.I.T. graduate student, Steve Russell. It has acquired many variations over the years, the simplest of which can now be found in coin-operated game machines.

On one version of *Space War* at M.I.T., two players sit, usually in the dark, in front of a large display screen, each facing a private keyboard. About ten of the different buttons on each keyboard steer the spaceships. Push one, and your ship accelerates forward with fuel flying out the back. Push another and your rocket turns. When the enemy ship sails in range you can repeatedly push the space bar and a stream of missiles will attack your opponent. If your opponent chooses, he can push a button to erect a radiation shield — a move taken as a last resort. The shield uses up precious energy necessary for maneuvering and prevents his counterattack. It does, however, stop a few missiles from exploding his ship and the loss of a point. A sun in the center of the display gravitationally attracts ships and missiles, vaporizing all that venture too close. The visual beauty of a fleet of missiles warped around the sun is a kind of treatment only computer graphics can offer. Other variations of this game include phasers instead of missiles, black holes to fall in, and multiple star systems.

Another popular game is called *Maze.* Up to five players are trapped in a maze under threat of discovery, blind to all but a tunnel ahead of them. One has the choice of turning, moving forward, or shooting a gun. When you move you see the sides of the walls whiz by. The "players" inside the graphic tunnel are typically killed many times in an evening.

Not all the computer games are so competitive or so violent. *Lunar Lander* puts a player on board a LEM falling towards the surface of the moon. Skill and planning are required to make a smooth slow landing without crashing on mountains or boulders, or running out of fuel. One version has a small MacDonald's on the lunar surface. If you land near it a tiny astronaut emerges from the lander and orders two cheeseburgers to go. Then he climbs back in the LEM and flies off.

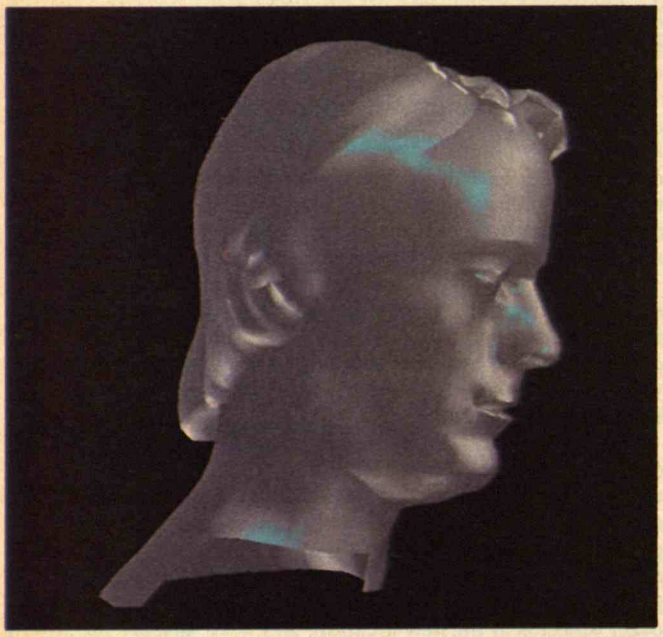
Dazzle Dart was inspired by the science fiction story, "Bullard Reflects," by Malcolm Jameson. It's best described as a kind of basketball or hockey, but with beams of light instead of a ball. One player has possession of the beam, and can shine it by pressing a button. The other players all have mirrors and can reflect the beam. The aim is to shine the beam into a goal by bouncing it off the mirrors of your teammates or opponents. The player who has the beam may pass it to a teammate, and a high degree of teamwork is required in the mental gymnastics of maneuvering and passing. Too many reflections and the beam is intercepted by the other team.

The programming of computer games is essentially the same as in computer animation, with the addition of a fast response to the game players' actions. To accommodate this, computer games either make use of very simple imagery when run on inexpensive equipment or are only run on fast, expensive machinery.

The typical program simulates an imaginary world. For example, to program the motion of a ship in *Space War,* one needs to keep track of the different forces acting upon the ship — gravity and rocket thrusters, its current velocity and position. At every refresh of the display the program must combine all the forces in order to draw the ship at its new position. In addition, the program must check to see if any other object is at the new location, and, if so, display the appropriate explosion. For the game to be successful, all these computations must be applied to every ship in the game in less than the minimum flickerless refresh rate, or about a twentieth of a second.

Even when a computer is simply a variation of a conventional game — such as *Monopoly,* Poker, Backgammon, Scrabble, or Chess — the addition of computer animation can change its character greatly. For example, a computerized version of *Monopoly* can depict a drive through a cartoon Atlantic City. Instead of shaking the dice and moving across a gameboard, a player might drive by Park Place only to run out of gas in front of a row of houses with a street sign reading "Boardwalk."

Simplified versions of these games are being manufactured as special purpose systems because of the huge cost savings. But the *Pongs* and *Space Wars* of pinball rooms are likely to become obsolete soon. Powerful general-purpose computers with much greater capabilities for about the same cost are due on the market soon. Any imaginable game could be programmed on these. Or if one doesn't feel inclined to program new games, one need only plug a cassette into the small computer and play from a large selection of marketed games. — *K.K.*



The familiar ABC logo shows the expertise in computer simulation of light reflection (above left). Although the process of creating a double for Peter Fonda (below) was not fundamentally different from object simulation, it anticipates the time when a computer may create characters to act, show emotions and speak as though they were real people.

A 40-second sequence of the movie, "Futureworld," shows Peter Fonda's clone spin, turn, and recede in space. To produce this duplicate, Fonda was dusted with white for high contrast, and a slide containing thousands of intersecting grids was projected upon him. He was photographed by synchronized cameras 45 degrees apart. These two perspectives were used by the computer to determine the location of, say, a point on his head while it is in motion. (Photos: Information International, Inc.)

that a particular character should walk in a bouncy energetic manner over to another character. The computer need only be told once, in a very general fashion what a "bouncy energetic manner" is and then it can apply the knowledge in diverse situations. Or, if a more abstract film is desired, one might indicate that one wants a film that portrays a bright pulsating circle and the system will make an educated guess as to what size it should be, how fast it ought to pulsate, what the background and color should be.

In the longer term, researchers in artificial intelligence and computer animation may some day make the term "computer animation" ambiguous. It will mean both "animation done on a computer" and "animation done *by* a computer." Today, the latter either does not exist or consists of films where nearly all the decisions made by the computer are based on a simulated flip of a coin. The day when such decisions might be based on a real understanding of perception and aesthetics may not be that far off.

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Kenneth Kahn is a graduate student at M.I.T.'s Artificial Intelligence Laboratory. He is the sole developer of Director, a computer language especially adapted for animation and has made several animated films with and without the aid of a computer. **Henry Lieberman** is a member of the research staff at the Artificial Intelligence Laboratory. He has designed systems for computer graphics and animation which are being used for research in artificial intelligence and education. He has worked on the implementation of Logo, a language used to teach children computer programming, and is currently involved with the development of Actor, a language for artificial intelligence applications.

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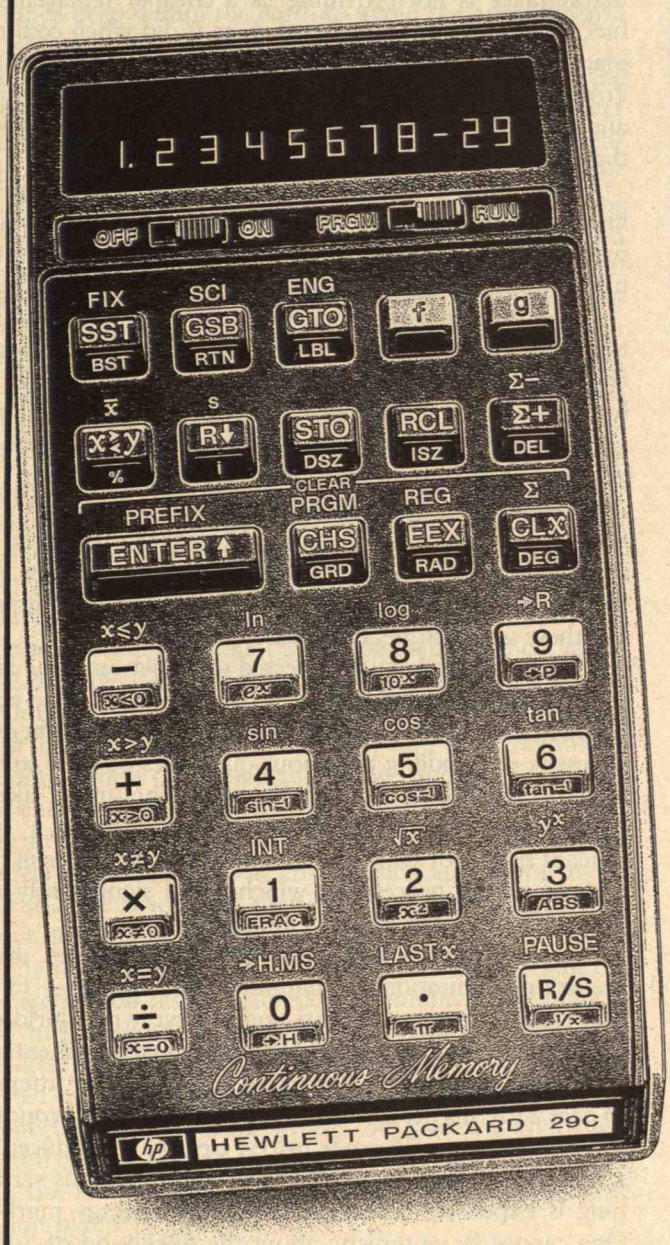

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Energy: Policymaking in a New Reality

Ben C. Ball, Jr.
Vice President, Gulf Oil Corp.; Adjunct Professor of Management and Engineering, M.I.T.

Nothing can return us to an era of ever more energy, ever cheaper. We must learn to live in a different world.

It is not appropriate to refer to our present situation with respect to energy as our "energy problem." The word "problem" implies that there is a solution or cure which, when applied, will permit a return to conditions essentially as they previously have been. But that is not the case with energy today. Nothing we can do will restore the conditions which prevailed in the second and third quarters of this century; our energy *situation* in the future will forever be fundamentally different from that which has prevailed in the past.

Our "energy problem" does not have a solution in the sense that we can win a war or put a man on the moon; rather, ours is a brand-new, long-term situation in which we must learn to live. And it raises a whole new set of issues with which we are largely unfamiliar and a set of social questions with which we are poorly equipped to deal.

The Crisis that Is Not a Crisis

Our first need in dealing with our new energy situation is to understand that it is authentic and long-term in nature; otherwise, our decisions will be inappropriate and their urgency will be underestimated.

Since the beginning of the industrial revolution, the development of western societies has been based largely on the premise that growing quantities of energy would be available at declining costs. This premise has been fulfilled because of improved technology and because of the fortuitous discoveries of progressively larger resources which were inherently cheaper to produce.

This situation has changed. There was a sharp rise in energy cost in 1973, apparently caused by the O.P.E.C. price increase. This so-called "energy crisis" may have seemed to happen overnight in response to a specific, unpredictable political change. But that was not in fact the case. Other, more fundamental factors were really at work. By the early 1970s, technological progress had flattened out; most of our large petroleum resources in conventional exploration areas had been discovered; and environmental concerns were changing the very nature of energy acceptable to the marketplace.

These factors came together to make our situation unprecedented: with consumption increasing, supply was suddenly decreasing. For the first time in our history, the marketplace is not providing us a cheaper replacement fuel as oil and gas are exhausted, as it did when coal replaced wood, and later, when oil and gas replaced coal. Prospective new energy sources, such as oil from shale, oil and gas from coal, and solar energy, are more expensive than oil.

Another way of saying this is that, for the first time in history, *marginal costs of energy exceed average costs* over the long term. A review of our present and postulated future energy resources will make this point clear.

Given the extensive domestic exploration and production of oil over the past 75 years, it is safe to say the large, cheaply produced onshore fields have, for the most part, been discovered and tapped. The oil and gas in our remaining reserves, then, basically lie in more remote frontier regions such as the Gulf of Alaska, and offshore in the Atlantic and the Beaufort Sea. Production costs in these areas will be an order of magnitude higher than those of most present production. Technological progress in enhanced recovery will produce some additional volumes, but these will also be at increased cost.

The cost of shale oil is expected to be between one and a half and two times present world oil prices. The economics of oil shale recovery are limited by the inherent necessity of handling enormous quantities of inert solids and of hydrogenation of the oil. The most likely technological breakthrough which could make a significant supply of shale oil economically available is in the area of *in situ* processing, which could significantly reduce either or both of these limitations.

Although the U.S. has substantial coal resources, there are definite limitations — man-made and natural — to its use. Coal utilization at costs competitive with world oil prices is limited primarily by the need for environmentally acceptable combustion. Stack-gas scrubbing, one attempt to deal with this need, makes coal submarginally economical relative to world crude prices; electricity produced in a new plant using high-sulfur coal with stack-gas scrubbing is expensive relative to the world energy market. One cannot be optimistic about the likelihood of a significant breakthrough in stack-gas scrubbing technology. On the other hand, the development of fluidized-bed combustion technology to the point that emissions from "dirty" fuel would reach acceptable levels due to changes in the combustion process itself are more likely.

The liquefaction and/or gasification of coal would permit coal to be burned in an environmentally acceptable manner, but the cost of synthetic oil and gas from

these processes is expected to be two to three times present world oil prices. The possibility of a technological breakthrough to reduce this cost is limited; the processes depend inherently on massive hydrogenation. As in the case of shale oil, a technological breakthrough in *in situ* processing might reduce or even eliminate this requirement, and therefore could make an appreciable supply of liquefied/gasified coal economically available.

It is worth noting that a true order-of-magnitude breakthrough in enhanced petroleum recovery would probably lead to a similar revolution in *in situ* processing of shale oil and coal and vice-versa. All these processes involve a common problem: controlling large quantities of fluids deep within the earth to avoid the huge expense of mining in one form or another.

Fission offered the hope of cheap energy during the 1960s. But since then unit capital costs of nuclear power plants have increased about five-fold, outpacing the general inflation rate in the construction industry. A substantial portion of this can be attributed to regulations stemming from safety and environmental concerns, and since safety and environmental requirements tend to become more severe with almost each new plant, one cannot be optimistic about any future reversal of this cost trend. In addition, the ultimate adequacy of U.S. uranium supplies at costs allowing electric generation competitive with O.P.E.C. oil is of some concern, and there also remain the issues of disposing of nuclear wastes and of the control of the plutonium produced in the reprocessing of spent fuel. There seems little likelihood of economical technological breakthroughs in the foreseeable future to deal with any of these problems.

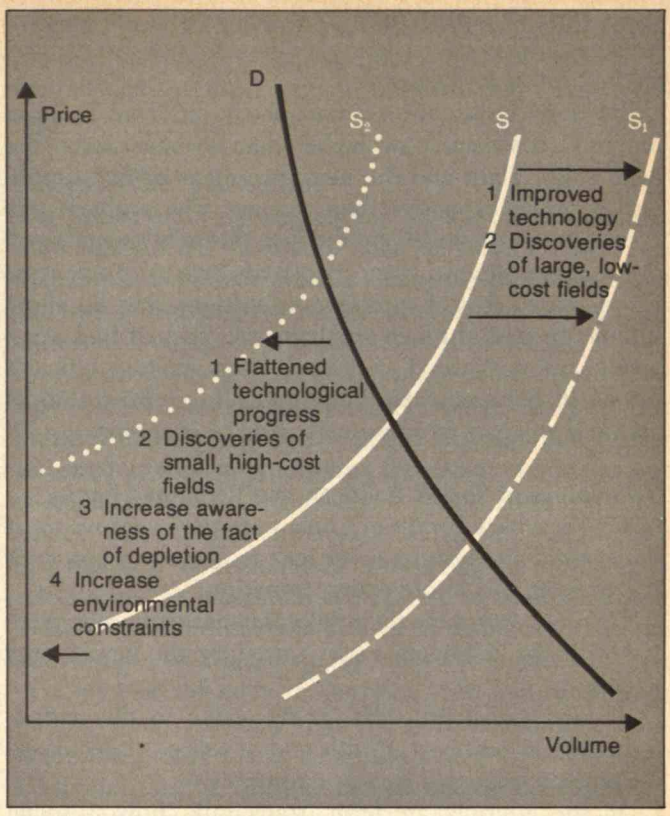
Hydroelectric power offers insignificant additional volumes of energy in the U.S. simply because most available damsites are already in use.

Only very limited sources of natural geothermal steam exist near the surface in the U.S., and this technology therefore offers only small additional volumes of economical energy. Forced geothermal ("hot rocks") and subterranean sources of hot water or dissolved methane are expected to yield energy at costs which are several times world crude prices and they cannot be expected to be a significant energy source in this century.

The technology for such "backstop" energy resources as breeder and fusion reactors is essentially in its infancy, and many economic, technological, and environmental hurdles must be conquered. None of these can be expected to make a significant contribution to our energy supply this century, and we can be confident that their capital cost — though we cannot be sure of their operating cost — will be inherently higher than that of present fission plants.

The use of solar energy in the form of sunlight, wind, and tides seems most appropriate during this century in isolated, site-specific cases. Significant use of these forms is still in the stage of research, not yet ready for development, demonstration, or commercialization.

Timber and biomass may eventually become significant energy sources, through such mechanisms as "energy plantations." However, technological and infrastructure problems present significant economic blocks.



A typical price/supply/demand relationship, depicting the operation of the marketplace. The price and supply can be read along curve S and price and demand along curve D. The real world operates at their intersection. In the past, over the long term, the supply curve for energy has moved to the right, toward S_1, because of improved technology and continuing discovery of large, low-cost resources. The results were increasing supply at decreasing prices. However, now technological productivity has flattened, environmental constraints as well as awareness of the fact of depletion have increased, and new discoveries are in smaller, high-cost fields. These new trends shift the supply curve not to the right but to the left, towards S_2. This new and unfamiliar dynamic results in lower volumes at higher prices over the long term, even with the demand curve fixed. The reversal in the movement of the supply function is at the heart of our new energy situation. Public management of the energy market would determine by direct government regulation the shape and movement of one or both curves, and the author argues strongly against it.

The Price of Cheap Energy

Our situation is made more dramatic by the fact that the U.S. has had by design and explicit government policy the lowest price energy among all the principal consuming nations. Despite our changed situation, we continue to maintain all or most of the programs which led to these low prices. Price controls on domestic oil production, for example, work to maintain consumer prices lower than the cost of the marginal supply, O.P.E.C. oil. Interstate natural gas is regulated at prices which average about one-fourth the equivalent price of world oil.

The utility industry provides one example of how these policies have impacted on our total energy situation. Utilities are regulated on the basis of return on investment. Historically, this gave them incentives to offer discounts to large, new users, since marginal costs in the long term were lower than average costs; in other words, the next plant would be cheaper to build than the last

plant was. This encouraged new investment and resulted in increasing return on equity, even under policies regulating return on investment.

But now the situation is completely different. Because marginal costs are now higher than average costs, the next utility plant and the next increment of fuel supply will be more expensive than the last. The problem this creates is compounded by the fact that while regulatory agencies are slow to grant increased rates to compensate for increased cost of capital improvement, they do allow utilities to pass through the increased cost of fuel. As a result, utilities are discouraged from making efficient trade-offs between capital and fuel. These circumstances assure high costs to consumers and the economy.

The Values of Social, Political, and Economic Equity

Given these new conditions, what are the issues we must understand and resolve as we seek to come to terms with our present and future energy situation?

We must determine the role of the marketplace in dealing with the following issues raised by the new energy situation:

☐ In the near term, what is the value to the nation, measured in terms of wealth and security, of decreased reliance on imported energy resources?

☐ In the intermediate term (transition), how is social equity achieved — in other words, how should the changes in our energy situation affect the redistribution of income and wealth among regions of the country and among social classes?

☐ In the long term, how are "backstop" technologies developed by, say, the year 2000?

As we seek to face these issues, we find we know far less than we should about the real role of energy in our economy. What in fact are the relationships between energy supply, demand, cost, and price, the quantity and quality of our gross national product, employment, income distribution, and inflation? These are crucial questions, and in our new energy situation the answers are still obscure.

Filling "Gaps" or Supply Demands

Two specific approaches to energy decisions seem to be embraced today in the U.S. On one hand, much thought and analysis are focused on energy "needs," or "gaps" in energy supply, to be made good by the provision of particular fuels or by conservation. Such analyses concentrate on physical flows, and technologies are rated according to how much energy can be brought on stream, and how soon, to cover the shortfalls and gaps. The concepts of supply, demand, and prices in the sense of conventional markets simply do not exist in gap analysis. The difficulty is that excluding prices from the analysis does not exclude real costs from the real world. In reality, energy costs, whatever they are, must somehow be paid by the economy.

The other approach is to focus on energy prices as they operate in a market economy. In this view, there is no such thing as an energy "gap": supply is always equal to demand (over any significant time period) except in the presence of price controls and rationing. Some supplies may be less desirable because they are insecure or because they damage the environment, but in all cases the central questions are the same: What price must we pay for energy? And what premium are we willing to pay to hold imports down or avoid environmental losses? From this viewpoint the most important fact about a technology is not the extent to which it may contribute a new energy supply but the cost of that new energy; for it is the cost of its product in relation to price that will determine whether a technology makes any contribution at all.

The difference in viewpoint is fundamental; it represents a difference in the perception of how the U.S. economy actually operates, of the driving force behind changes in the energy sector, and of the policy tools available and likely to be applied.

If the problem is formulated in terms of "needs" and the failure of assured supply, then the task of government is to find, design, and build new supply and utilization technologies and ensure (somehow) that they are used. If the policy tools are available and the society wills to use them, then this view is perfectly appropriate. This is the way energy is managed in the centrally-controlled economies (where the "needs" approach is called the method of "energy balances"). Many services — the post office and highway system, for examples — are provided in this way in this country, and this approach was successfully and appropriately used for planning and providing supplies of key commodities during World War II. For example, the "gap" left when the Japanese achieved control of natural rubber supplies was successfully closed by government-supported production, supplemented by detailed regulation of the importing, pricing, and utilization of available synthetic and natural rubber supplies.

But is this "needs" approach appropriate with regard to U.S. energy policy over the next few decades?

In the past, energy supply in the U.S. has been left to the workings of private markets — some regulated and some not. Energy prices and the relation of those prices to the costs of domestic supply and conservation measures have been the principal determinants of the U.S. energy sector and of our country's energy imports. The driving force has been profits, with the government as one of the determinants of what was profitable and how much profit was appropriate.

Should this traditional reliance on the market mechanism continue? Does the national security problem presented by dependence on imported oil require a drastic change? Are the high energy prices implied by a commitment to U.S. energy independence socially intolerable because of the potential impact on lifestyle and on income distribution?

Technology vs. the Marketplace

My hypothesis is that for the foreseeable future — say, the next few decades — we are *not* likely to institute fundamental changes in the structure of the energy sector or move in a determined, decisive way to a more centrally-controlled energy economy. For better or worse, the market system will continue to predominate in the U.S. This does not propose the existence of some idealistic "free" marketplace. Rather, it assumes that constraints and

incentives will be used by the government, as in the past, to influence marketplace decisions but that — as in the past — these activities will not displace the functioning of the marketplace as *the* decisionmaking process. As an analogy, the government can have goals for unemployment and inflation but does not control or direct them; rather, it influences — through such tools as monetary and fiscal policy — the marketplace decisions which do in fact determine employment and prices.

Under a market-dominated policy, energy conservation — for example — would be in fact the natural result of each energy consumer taking steps which seem to him logical in view of the price signals he receives. One of the most significant consequences of such a policy — with certain government influences removed — would be rational utilization of our various kinds of energy, e.g., liquid petroleum for transportation, natural gas for domestic and commercial heating, coal for industry, and coal and uranium for utilities (thus reducing or eliminating any "need" to convert fuels — for example, from coal to liquid or gaseous fuel). Another would be a shift from private cars and motor freight toward mass transit and rail freight. To some extent educational and cultural pressures (e.g., preachments and posters) take the place of (or at least affect the decisions within) the market system; but we are learning that such strategies are essentially ineffective unless reinforced by the structure of prices.

The methods of "gap" analysis (which tend to ignore prices and profits) involve analytical and planning tools and, more importantly, policy prescriptions that are inconsistent with the facts of our economic organization. For example, "commercial demonstration" of new technologies to augment supply or diminish demand — synthetic liquid or gaseous fuel from coal is a widely discussed case — can lead to economically viable new industries only if prevailing prices are high enough to provide incentives for investments to bring the new technologies into use. When the role of prices is ignored, the implicit assumption is that when new technologies are demonstrated as *technically* feasible and uncertainties regarding costs and productivities are "eliminated," commercial penetration is assured. Effective "demonstration" of new technologies can permit earlier commercialization if it reduces risks, lowers subsidies, or provides more effective design; however, *commercialization* will only occur when and if prices are high enough to cover costs and investment risks, or when the government subsidizes the difference.

Americans seem to take on faith that technology, given the proper amounts of time, money, and brain power, can accomplish any feat and cure any ailment. We have to learn that this is not the case, that technology, like any other possible response to our energy situation, has limitations and restrictions which are dictated by laws of nature and principles of economics.

The basic problem with "technological" solutions to our energy situation is that, even making reasonable assumptions for future technological progress, all new future energy sources which promise to be available in significant quantities will cost appreciably more than present sources. From this perspective, one might say that O.P.E.C. has not set world oil prices high enough for us to solve our problem technologically. (Viewing O.P.E.C. from a commercial viewpoint, this should not be surprising.)

Energy in the Marketplace

The operation of the marketplace in an economy such as ours is based on the premise that the sum of many individual decisions, each made in the context of what is best for that individual, results in patterns that are best for society as a whole. The traditional role of the private sector is to offer these choices and make those decisions in that context. Because of the central role of energy in our industry and daily lives, the public has taken an unprecedented interest in controlling the energy market as our energy situation has deteriorated. This is contrary to the basic concept of the marketplace, which holds that no one is in charge of understanding or directing the market; it is self-directed by individual choices and by trial-and-error.

Now questions are being raised as to the ability of the marketplace to cope adequately with the energy situation in a manner tolerable to suppliers, consumers, and the public; some advocate that the government must predetermine answers and distribute allocations. The decision before us, between letting the market decide energy choices by trial and error and predetermining answers and distributing allocations, is as sharp and vital as the decision between natural selection and biological engineering. Each approach involves its own kinds of risks and dangers; the choice among them needs to be made carefully and knowledgeably.

There is no policy which will return us to the former times of plentiful, ever-cheaper energy. We do not have a problem to solve; rather, we have before us the challenge of deciding *how to adapt* to the wholly new situation in which we find ourselves.

Suggested Readings

Lodge, George C., *The New American Ideology,* Alfred A. Knopf, New York, 1976.

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Unconventional Food: Menu for Tomorrow

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M.I.T.

The incorporation of novel materials and technologies in food and feed is even now an evident trend in the U.S. and Europe.

Since 1950, the world has had to find food for an additional billion people, and the time in which to increase food production for the next billion will be even shorter.

Before World War II only Europe was a net importer of food, but since then, virtually all other regions of the world have become increasingly dependent on food imports from North America and, to a lesser extent, from Australia and Argentina. In most countries food production has failed to keep up with population increases and the food demands occasioned by rising affluence and living standards.

A National Research Council report, "Population and Food: Crucial Issues," emphasizes that the scale, severity, and duration of the world food problem are so great that a massive, long-range innovative effort unprecedented in history will be required to master it. More recently, the N.R.C.'s "World Food and Nutrition Study: The Potential Contributions of Research" has confirmed this prognosis. In fact, the study finds that malnutriton will not be alleviated unless developing countries can double their own food production by the end of this century. Although these countries were able to increase production by 38 per cent between 1965 and 1975, the additional 100 per cent increase ". . . will not be easy to achieve and sustain," according to the N.R.C. report. Furthermore, if developing countries continue to import increasing amounts of food from the U.S., our own productivity must increase at an appreciable rate.

There is little doubt that the production of traditional food sources can be tremendously increased by the application of currently available technology. Future research gives promise of continuing gains, but we must also look to development of unconventional technologies for food production and of novel food sources as potential resources. Indeed, such development is among the priorities of both N.R.C. reports.

Drawing upon a recent study conducted by M.I.T. for the National Science Foundation under its Research Applied to National Needs (R.A.N.N.) Program, I will review the contributions experts foresee from novel food sources and unconventional technologies of food production in the decades ahead.

The Fixation of Nitrogen

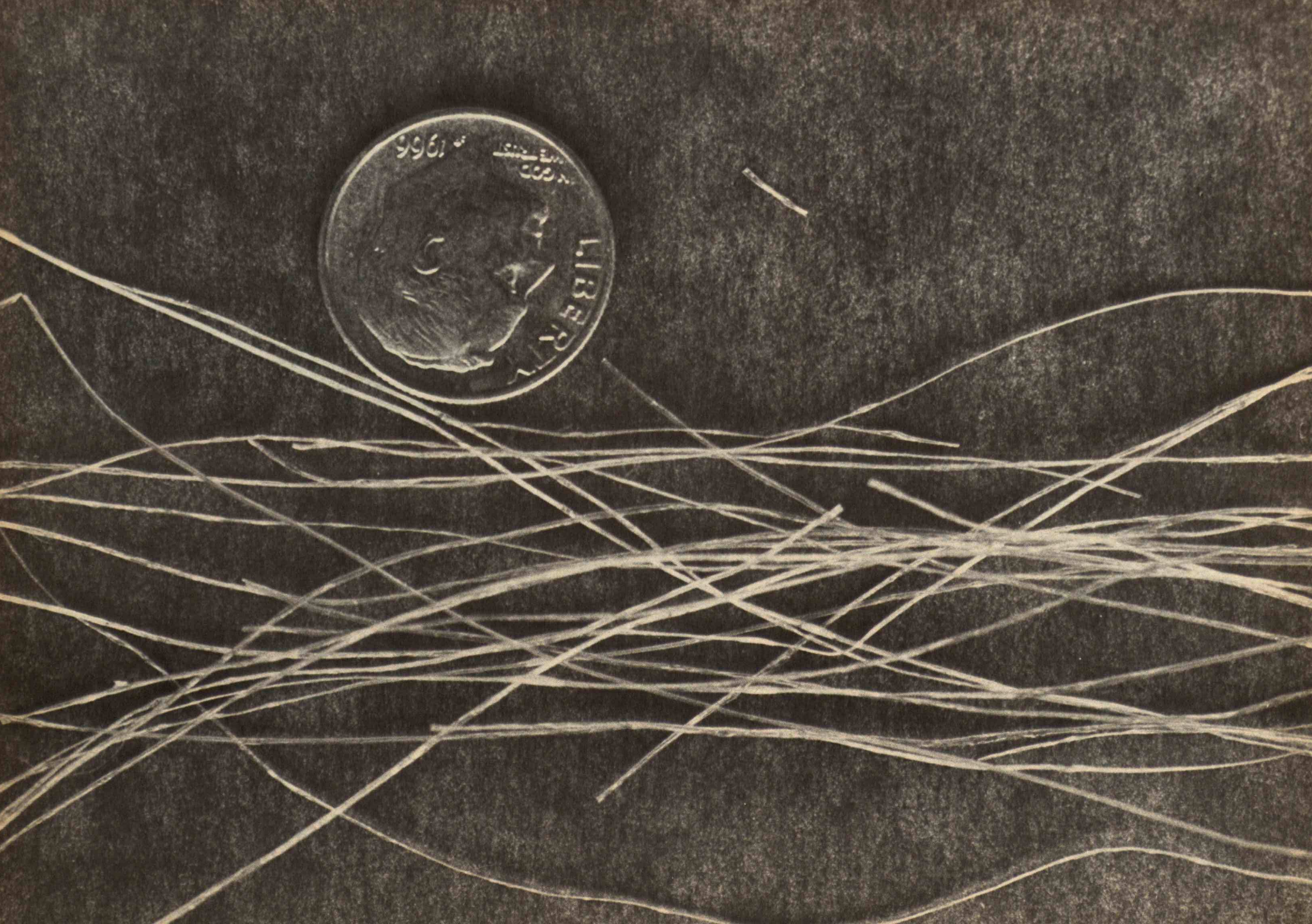
An example of unconventional research to improve traditional agricultural crops is the work on biological nitrogen fixation. It is necessary to pay particular attention to protein foods in view of their critical importance in human nutrition. Proteins are key components of the enzymes controlling all body processes, as well as the fundamental component of muscle, brain, and nerve tissue, and all body cells.

Nitrogen is vital to increased food production, but the cost of nitrogen fertilizer has increased sharply with rising energy costs. We know that some plants — notably the legumes — host microorganisms that have the ability to convert atmospheric nitrogen into chemical forms that are useful as plant nutrients. The protein nature of the nitrogenase complex that catalyzes nitrogen fixation in such microorganisms in soybean and lupine noodles is fairly well understood. But enhancement of such biological fixation — whether by symbiotic microorganisms attached to the plant roots, or non-symbiotic, through introduction of the enzyme complex into the plant itself, requires greater understanding of the processes themselves and of the organisms that have this capacity. For example, research is needed to determine the enzyme mechanisms and the forces that power the overall reaction. The genes coding for nitrogenase in bacteria have been successfully transferred from one species to another. Thus, a potential exists to improve the nitrogen-fixing capacity of organisms by means of genetic manipulation. Useful application of biological nitrogen fixation to grasses might even be achieved once we understand more fully the genetic and biochemical compatibility of hosts and endophytes.

Milk from Whey

Casein, caseinates, certain milk protein, and whey proteins from modified and fermented whey are secondary dairy products, connected with cheese technology and casein manufacture. All are highly nutritious. Unfortunately, these proteins are now largely wasted; they deserve attention because they can improve the protein yield

Thin strands of man-made protein utilize two types of simple protein which, when combined, are more nutritious than either component alone. The core of the bicomponent fiber is a single-cell protein made of petroleum-grown yeast. It is coated with a skin of zein, a fiber-forming byproduct of corn oil production which is usually used for animal feed. (Photos: Roger Goldstein)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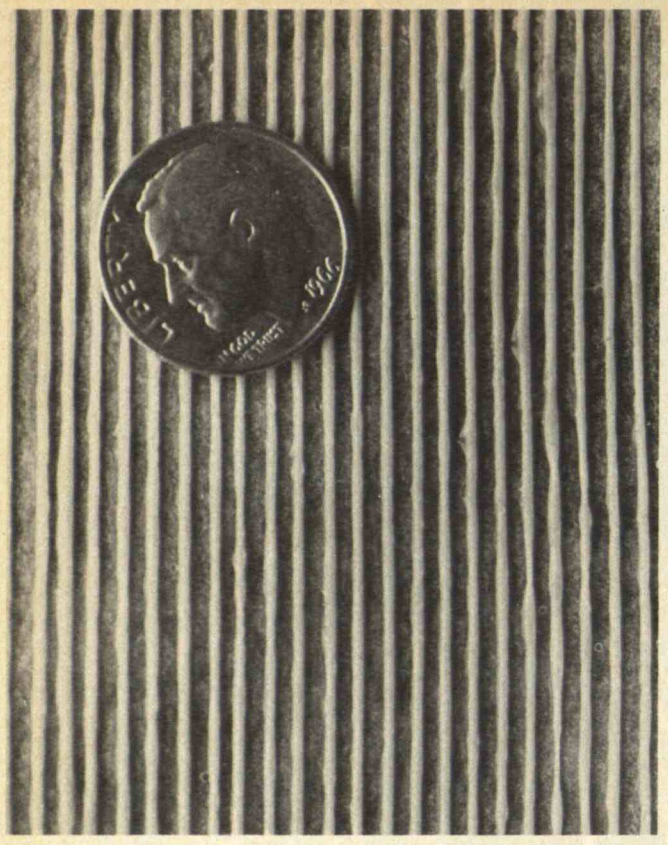


Bicomponent protein fiber is spun into threads from a paste-like glob and wound upon rolls for drying. These fibers, invented by Professor Cho Kyn Rha and Research Assistant Jyothi Kamath of M.I.T.'s Food Science Materials and Processing Laboratory, could be frozen, dried, canned, or refrigerated for use as a meat substitute.

of cheese and casein production. Whey could be formulated with full-fat soya flour, vegetable fats, carbohydrates, and vitamin-mineral supplements to provide a low-cost, highly nutritious milk for infants and children.

Amber Waves of Grain

Low-cost cereal grains and their under-utilized milling by-products such as brewers' spent grains, corn gluten meal, shorts, bran, and mill feed grains are abundant in this country. Scientific and technological effort could upgrade their food use and nutritional value. The potential benefits of producing protein concentrates from cereals seem particularly promising for both domestic and foreign markets. For example, wheat protein concentrates prepared from dry milling or wet milling of wheat or wheat byproducts are becoming available. Nutritious and low-cost oat protein products have been prepared experimentally from the wet milling of oats.

Corn germ flour is now commercially prepared by dry millers for the food industry by refining the germ separated from the corn after oil is extracted. Formerly used for animal feed, it is now expected to contribute nutrient value to many processed foods. Additional food technology research is needed on corn germ protein isolate, and on corn proteins isolated from corn endosperm by the wet milling industry — another byproduct normally consigned to animal feed.

Blood, Bones, and Broken Eggs

The potential for expanded development, production, and use of unconventional products from the meat and poultry industries is also great. Centralized packaging of meat prior to distribution in retail outlets has already increased the use of bones and fat because they can be used for pet food rather than discarded as household waste.

Blood, a byproduct of slaughter, contains 17 per cent protein and is usually processed into animal feed. The total recovery of this material as food could result in the production of over 400 million pounds of protein per year in the U.S. alone.

Approximately 5 per cent of the eggs used for hatching prove to be infertile; these eggs, identified by shining a light through them, could be removed from incubators at an early stage and processed for human food. A similar proportion of U.S. egg production intended for human consumption is designated unfit when received at processing plants because the eggs have embryos, cracked shells, blood spots, and other minor defects. This represents a substantial loss of safe, edible protein.

At present, federal regulations limit the addition of plant proteins to meat products. For example, sausage must be labeled "imitation" if it contains more than 2 per cent of isolated soy protein. The requirement makes no nutritional sense, and as long as no deception is involved, it is not in the consumer's interest.

The Sea's Untapped Harvest

Most of the fish species from U.S. waters that are traditionally eaten by the American consumer are either fully exploited or depleted. But species exist that remain largely unexploited or underexploited. For example, bottom fish, unpalatable in their original form, could be harvested to yield between 100,000 and 500,000 tons per year and could be offered in the form of engineered, fabricated foods simulating fish products more familiar to the general public.

"Trash fish" (species not desired for human consumption) are caught during shrimping operations and discarded. They could be used as raw material for the manufacture of fish meal. Between 250,000 and 500,000 tons are available per year and are now wasted.

Squid populations are so generous that the U.S. catch on the East and West Coasts could be increased from 13,000 to 500,000 tons per year, once technologies for locating, harvesting, preserving, and processing squid are developed and a market is created for domestic consumption or for export. Squid is now eaten directly as food, but it could also be used in textured and engineered food products.

A further source of aquatic protein stands in a class by itself: Antarctic krill, the single largest natural source of animal protein in the world. A conservative estimate of the krill resource puts the standing crop at 100 million tons, and possibly 50 million tons per year could be harvested without diminishing the resource. If the U.S. were able to take even one-tenth of this annual potential harvest, we could in theory equal our yields from all conventional aquatic sources. Krill also represents a source for chitin, an important natural polymer capable of replacing

certain petroleum-derived products *(see July/August, p. 70)*. Management of this resource, however, raises a series of very difficult problems, among them the difficulties of catching and processing the fish in hostile Antarctic waters and finding acceptable ways to use them.

Many of these increased aquatic food resources will consist of raw material derived from species largely unfamiliar to the average U.S. customer. For psychological and economic reasons, such new food products will probably have to be presented to the U.S. consumer in a processed form so that the original raw material is no longer recognizable.

Food Grown on Oil and Gas

Non-photosynthetic single-cell protein (SCP) is a generic term for protein produced by single-cell organisms such as yeasts or bacteria that ferment petroleum derivatives or organic wastes. Some forms of SCP have been used in human food for millennia; any fermented food product — yoghurt, wine, and many cheeses, for example — contains significant quantities of cellular organisms as diverse as bacteria, yeast, and fungi. Thus there should be nothing fundamentally objectionable in the food use of these species.

The raw material chosen for SCP production depends, to a very large extent, on local availability. Natural gas or methane would be reasonable choices in areas where they are available in abundance and where they are now even discarded as flare gas. Less desirable petroleum fractions could be used, and local economics will determine whether any of these — crude, semi-purified gas and oil, or refined fractions — are the most feasible substrates. A number of research groups have concentrated on processes that use a relatively pure paraffin distillate for production of either food or feed.

Methane is frequently available at low cost. Its direct fermentation appears limited to bacteria, however, and no large-scale, continuous process has yet been developed that provides sufficiently high cell growth rates and cell concentrations to be economically attractive.

Alcohols, particularly methanol and ethanol, can be derived from gaseous hydrocarbons via catalytic hydration, and both of these can be utilized by a wide variety of microorganisms. They can be prepared with purity adequate for use in food, they are totally water-soluble, and leave no residues to contaminate the cell mass. Because these lower alcohols exhibit advantages of both hydrocarbon and carbohydrate fermentations, they currently have the best potential for SCP processing, and they are particularly attractive as a source of food protein.

There are also a variety of fermentable carbohydrate sources. Sulfite waste liquor and whey are good candidates in some geographic areas. Cellulose is the most abundant carbohydrate raw material, available from waste paper, bagasse, wood pulp, sawdust, etc. In the U.S.S.R., hydrolyzed wood pulp supports a feed yeast industry estimated at approximately 1 million tons per year. Solid cannery waste and citrus waste are possible sources of carbohydrate, but seasonal processing schedules and the fact that the material is sometimes dilute present problems. Even animal waste and manure can be recovered and refed to livestock after microbiological processing.

Starch is much more readily hydrolyzed than cellulose, and the potential exists for direct fermentation of starch by fungi in a continuous process. Starch may be of particular interest in tropical areas that produce high yields of starch root crops such as cassava. Sugars such as molasses are similarly useful substrates for fermentation. Both are sometimes available in excess in tropical regions. Bacteria, yeast, and fungi are all being considered for use in pilot or commercial scale food processes.

The high content of ribonucleic acid (RNA) relative to protein in SCP is the major limitation to using SCP in food at higher than food additive levels of 3 to 5 per cent. Methods have been devised for RNA removal, although they add to the cost of processing. Selective isolation of proteins might be a method to avoid the RNA problem. Chemical, mechanical, and enzymatic means of cell disruption have been tried, but their expense is discouraging. Possible genetic solutions involve isolating "fragile" mutants (mutants with cell walls that break more readily) and temperature-sensitive hyperlytic mutants. Research has yet to be done on how SCP can be applied in the manufacture of food; studies are needed of engineering properties, interactions of SCP with food constituents, and the use of SCP in the production of textured protein.

The protein nutritional quality of SCP is high, but because SCP is deficient in sulfur amino acids, it does not compare well with the nutritional quality of animal proteins. Studies at M.I.T. indicate problems of human tolerance to some SCPs that were not revealed in extensive toxicological studies in experimental animals. We believe that this problem can be overcome by relatively simple processing procedures.

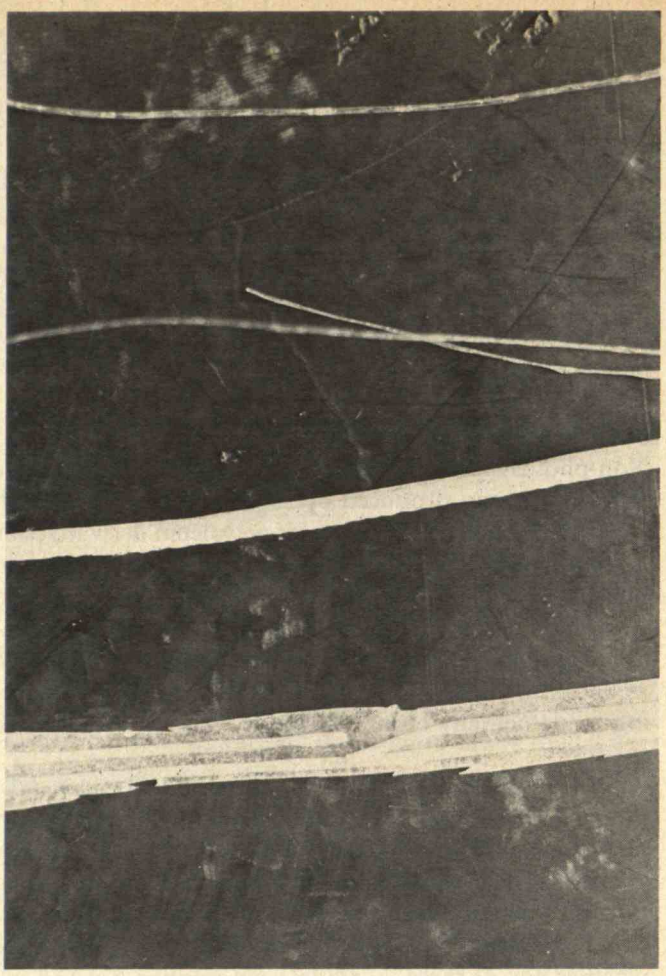
Nutrition from Ponds, Protein from Leaves

Photosynthetic single-cell protein: a long label for a simple organism, algae. It is found suspended in shallow, illuminated ponds in whose waters are dissolved simple salts such as carbonates, nitrates, and phosphates. Depending on growth conditions and genera, algae may contain between 8 and 75 per cent protein, and the biological value of algae varies from about 50 to 70 per cent of that of egg. Nutritionists have concentrated primarily on three genera — *Chlorella, Scenedesmus,* and *Spirulina* — which, when separated, form a dark green slurry or paste containing 5 to 15 per cent solids that may be consumed directly by animals or preserved by freezing or dehydration. For poultry and livestock, algae have been mixed with cereals and manufactured into pellets. For feeding hogs the nutritional value of waste-grown algae appears equivalent to that of meat and bone meal and superior to an equal weight of soybean meal. Waste-grown algae could also be a good supplement to the range feed of such stock as cattle, sheep, and goats. Heat-dried algae flakes or chips can be ground into a very fine, green flour, but only a fanatic would call it palatable.

Green leaves provide the primary and largest supply of protein in the world, but leafy plants are also rich in structural materials — cellulose, lignin — that are largely indigestible by man and other single-stomached animals.

Animals such as cattle and sheep that have a rumen (a gastric compartment that breaks down cellulose) or animals such as horses and sheep that have a functional caecum (a blind pouch where the large intestine begins) can digest cellulose through the action of symbiotic microorganisms. Leaves from forage crops such as alfalfa and from wastes in the production of vegetable crops are a prodigious protein resource. For example, in 1973 and 1974, the protein in U.S. alfalfa amounted to almost twice the protein in the 13.8 million tons of soybean meal marketed in this country.

Typically, such forage has been used for animal feed as fresh, whole forage, by field-curing prior to storage, or as silage. We now know that leafy crops dehydrated by pressing yield a product superior to conventionally preserved forage for many reasons, not the least significant of which is the higher retention of nutrients. The juice that is pressed out contains 25 to 50 per cent of the leaves' protein and may be used as a protein source. The juice needs no further treatment and can be mixed in pig rations just prior to feeding. It may also be heated or acid-treated to coagulate the protein as a curd that may be used as a poultry or swine feed, or as a human food. Further, the juice may be treated to separate a chlorophyll-containing fraction for animal feed plus a colorless fraction suitable for human consumption; both the feasibility and economics of this process remain uncertain. The nutritional value of whole-leaf protein products is in the range of that of soybean meal and may be further improved if supplemented with methionine.



After bicomponent protein fiber is dried upon rolls of paper (bottom) it must be processed further. The unstretched fiber (center) is brittle; after stretching (top) to align the molecules of the zein which hold the yeast protein in strands, the fibers become stronger and more closely resemble the meat fibers they are to replace.

Better Nourishment through Chemistry

Satisfying some human food needs by chemical synthesis is a remote possibility. For example, "formose" (heated glucose and formaldehydride) can be combined as a polymer with hydrogen cyanide (HCN) to produce amino acid mixtures, but yields are very low and many problems remain to be solved, including toxicity of other compounds in the mixture, poor taste and texture, and high cost. Stimulated largely by the demand for food during World War II, German scientists developed several processes by which fatty acids can be synthesized from petroleum hydrocarbons at current costs of about 10 to 20 cents per pound. Much more extensive studies of the products will be necessary, including tests for toxicity.

The synthesis of glycerol for human food has also been investigated, most energetically by N.A.S.A., as a potential energy source for a space colony. Commercial synthesis began with propane and resulted in a product costing about 40 cents per pound. However, another approach through formose sugars is potentially much cheaper, largely because it promises greater yield. However, the nature of the other reaction products, including their safety and potential uses, will need investigation.

Novel Food from Shelf to Kitchen

Novel food products will be slow to penetrate the market because many will be expensive and because the food industry and the consumer may be reluctant to accept them. The more innovative a food product, the more the consumer is asked to learn about its benefits and uses. The harder the consumer is to persuade, the higher are the risks for a commercial producer to develop and market the product. Such risks, the long period required to develop and test the product, and the large amounts of capital required all work to make the food industry extremely cautious in evaluating radically new food products.

Safety is an essential consideration when novel proteins or proteins processed in novel ways are to be used for human consumption. Extensive tests using experimental animals are essential, but in many cases symptoms that may appear in human trials do not appear in experimental animal tests. So studies on experimental animals are not sufficient to eliminate all possibilities of adverse reactions in man, and animal tests must be followed by cautious and systematic tolerance studies using human subjects. The need for thorough studies is particularly evident for such proposed new sources as single-cell protein, forage and leaf protein concentrate, and new legume and oilseed plants. Even soy protein should be carefully tested when it is processed in wholly new ways.

Bureaucrats in the Supermarket

Food laws will constrain the introduction of new protein foods from both unconventional sources and unconventional processes in a variety of ways. Present standards were developed or amended by the Food and Drug Administration only after long research and protracted public hearing. Depending on their novelty, protein concentrates produced by fermentation on chemical substrates are sure to be considered food additives.

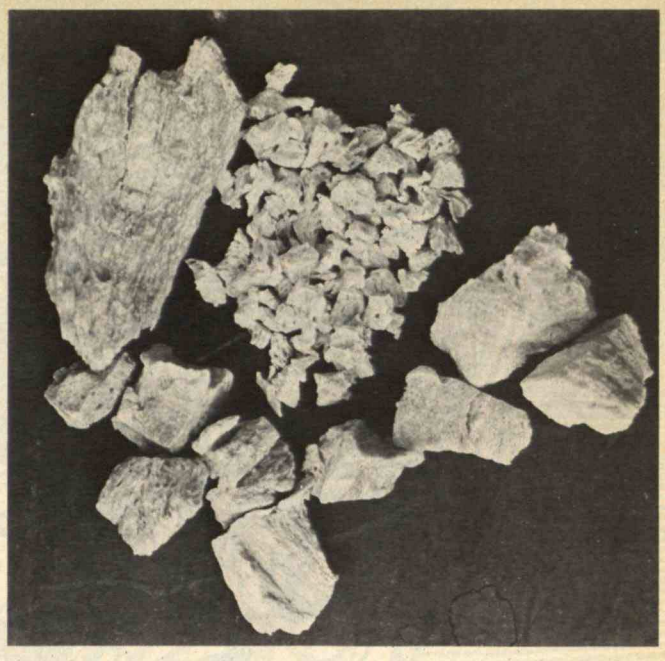
The Food Additives Amendment of 1958 has now been applied through F.D.A. regulations to any component or even ingredient of food; thus the legislation is a fundamental constraint on the development of novel foods. Food yeast grown on an unconventional substrate, or a new genetic variety of a grain cultivated for high lysine content, could be subject to F.D.A. review. Given the F.D.A.'s historical opposition to filled milk (made by adding vegetable oil rather than higher-priced butterfat to reconstituted dried skim milk), vitamin-mineral fortified sugar, and wholefish protein concentrate, we cannot expect that future F.D.A. policy will facilitate the introduction of radically new protein resources.

Present and prospective world food needs demand careful vision and judgment. We must not only remove unnecessary legal constraints, but we must go still further to encourage the technological development of new food resources. A great deal more toxicological research on food than is conducted at present will be necessary both to identify reasonable regulatory standards and to produce new food products that will meet those standards.

Real innovation almost always threatens someone, at least in the short run. It is for this reason that many of the disagreements that result from attempts to introduce new protein foods are resolved in the political arena, or even come to litigation. When the many opportunities available to any one group for blocking an innovation are multiplied by the many groups that may oppose the innovation, the effect on a new proposal is often debilitating and occasionally fatal. Consumer pressure for traditional or "natural" foods may also obstruct the marketing of new proteins.

We may be sure that incorporating new foods into human diets will continue at a pace that must increase as pressures on traditional food supplies grow more severe and as costs rise. But economic, nutritional, safety, legal, political, and marketing obstacles will delay the process so that a calendar for these new developments is difficult to predict.

Before novel food resources and processing techniques can be tested in the legislature and the marketplace, problems of supply and nutritional value must be resolved. Even then, basic food science and technology problems of processing protein resources will remain. To solve them, protein fractions and protein molecular species must first be isolated and analyzed. Next, the interaction of these protein materials as food must be examined. And finally, the properties, quality, and acceptability of the final food products must be evaluated. Unconventional protein resources can be tapped most effectively by breaking down the raw materials and combining selected components into edible products. This approach will be more costly than processing protein concentrate byproducts from oil recovery operations, but promises to yield more sophisticated and palatable food — food that people will be willing to purchase and eat. The incorporation of novel materials and technologies in food and feed is even now an evident trend in the U.S. and Europe. Given fairer and more objective regulatory standards and procedures, innovative marketing and promotion of novel foods, and favorable prices, the trend is likely to accelerate and spread to other parts of the world.



Many forms of vegetable protein processed as meat substitutes are now commercially available. The usual ingredient is soy flour; those shown above are used to extend hamburger and chicken.

Suggested Readings

Protein Resources and Technology, M. Milner, ed., Westport, Conn.: A.V.I. Publishing Co., in press.

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Food and Agriculture, A Scientific American Book, San Francisco: W. H. Freeman and Co., 1976.

Lappé, F. M., and Collins, J.: *Food First: Beyond the Myth of Scarcity.* Boston: Houghton Mifflin Company, 1977.

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Currently, he is Chairman of the Advisory Committee on Medical Research of the World Health Organization, Senior Adviser to the World Hunger Programme of the United Nations University, and Vice President of the International Union of Nutrition Sciences. His awards include the International Award of the Institute of Food Technology, the Goldberger Award of the American Medical Association, and the Osborne, Mendel, and Elvehjem Awards of the American Institute of Nutrition.

Space Law

As earthkind gives birth to spacekind, an enormous body of law will be needed to govern the complexities of life on the new frontier. The progress so far has been sketchy — with a lot of wishful thinking.

George S. Robinson
Smithsonian Institution

An exciting body of law governing activities in outer space has been quietly developing, and it may be critical to shaping humankind's future on earth, as well as off. This body of "space law" has been evolving mainly because of the complex legal ramifications produced by earth satellites and manned space missions. Despite its profound potential impact, space law has thus far been more or less a hobby of lawyers, with the exception of the pioneering activities of a few dedicated international jurists. Lacking background in the natural sciences, lawyers have done the best they can, but a more concerted effort by a larger number will certainly be needed.

Space law can be broken down into two broad categories. First, there is an evolving body of rather mundane but essential earth-oriented space law, ranging from communications satellite law to product liability in the manufacture of space equipment. The other category of space law consists of the more exotic, embryonic principles and laws that apply to existing long-duration manned missions, as well as the permanent space communities of the near future. Many of these laws are unresponsive to new technology and scientific data, and are a bit shopworn in terms of their underlying justifications.

High Principles, Down-to-Earth Motives

Three or four basic international treaties, together with their supporting domestic legislation, form the basis of earth-oriented space law. Among the private and public international organizations with significant roles in carrying out these laws are:

☐ The Committee on Space Research
☐ The International Council of Scientific Unions
☐ The International Telecommunications Satellite Corp.
☐ The International Telecommunications Union
☐ The World Intellectual Property Organization
☐ The International Astronautical Federation
☐ The Food and Agricultural Organization
☐ UNESCO
☐ Various regional organizations such as the European Space Agency.

The basic treaty governing conduct in outer space is the United Nations "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies." It is usually called the Outer Space Treaty and was opened for signature in 1967. Its noble-sounding, all-inclusive title does full justice to its high aims. As we shall see, however, selfish motives prompted the Treaty's approval by at least some of the signatories. The Outer Space Treaty was spurred in part by the earlier U.S. Aeronautics and Space Act of 1958, which espoused similar peaceful and beneficial aims for space. Specifically, the Treaty provides that:

☐ Space exploration shall be conducted for the benefit of all countries, and shall be the province of all mankind.
☐ Outer space and celestial bodies cannot be claimed by any country for itself.
☐ Space research is to be carried out in the interest of furthering international cooperation, understanding and peace everywhere.
☐ Outer space may not be used for the placing of nuclear weapons or other weapons of mass destruction, nor shall

Illustrations by Judy Richland

there be any military bases, installations or fortifications, maneuvers, or weapons testing in outer space.

☐ Astronauts shall be considered as envoys of mankind and shall be given assistance and protection in their endeavors.

☐ States, governments and international organizations shall have certain liabilities for activities and accidents arising from space exploration.

☐ Efforts will be made to avoid contaminating celestial bodies or harming the earth environment as a result of the introduction of extraterrestrial matter.

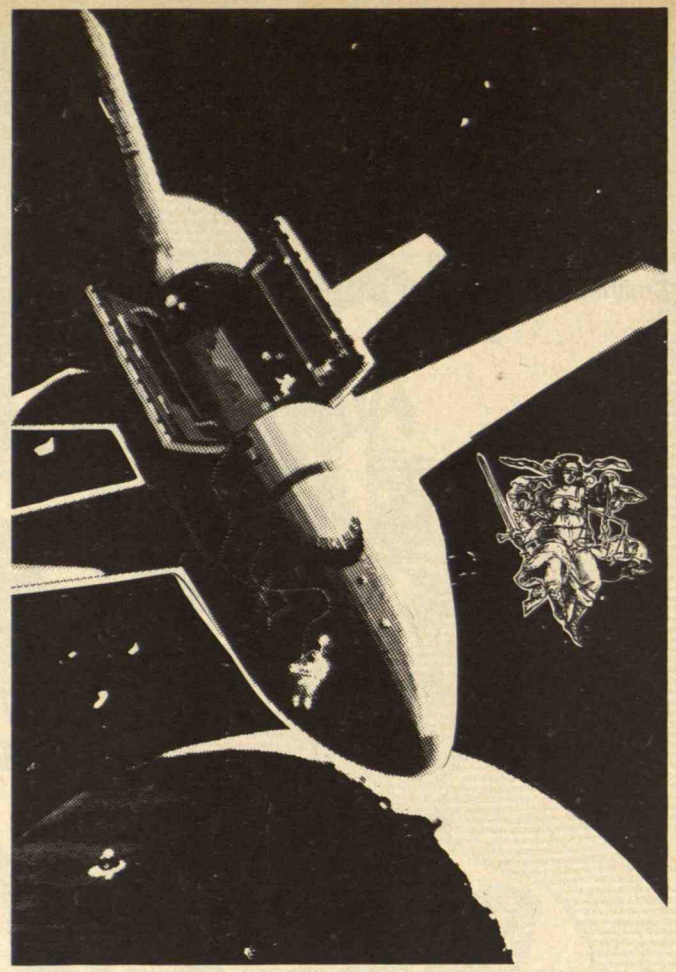
☐ The signatory states must consult with each other when there is reason to believe a planned experiment would cause harmful interference with other activities or interests of the signatories. They must arrange for visual observations by member states on the basis of equality regarding various activities; the purpose being to encourage international cooperation in space research.

Despite the nobility of these peaceful sentiments, the Outer Space Treaty also arose from considerations every bit as practical and parochial as those underlying the early Law of the Sea which gave all nations the "absolute right of innocent passage," as Dutch jurist Hugo Grotius termed it in 1609. In those days intensely competitive exploration and colonial trade raised fears among the great seafaring nations that individual assertions of exclusive rights on the high seas would disrupt their lucrative ventures.

In fact, since the Outer Space Treaty was opened for signature, lawyers, politicians and statesmen have consistently tried to reinterpret the document as space capabilities advanced, to give their home nations domestic and military advantage. More of the same can be expected, especially considering how the evolved law of the high seas is being trampled beneath today's mad scramble for ocean resources.

Our country's bilateral agreements with other countries establishing joint space ventures have been perhaps the only true examples of the use of space to benefit all mankind. The original act of Congress establishing the National Aeronautics and Space Administration in 1958 formed the basis for these agreements, which allowed participation of numerous foreign countries and scientists in U.S. space missions, with considerable sharing of resulting data.

This is not to say the Outer Space Treaty has been useless; it has provided the framework for a number of limited accords between individual countries, as well as several practical international conventions and treaties. For example, the international Convention on Registration of Objects Launched into Outer Space was ratified by the U.S. Senate in June, 1976, and makes mandatory the registration and reporting of launchings into outer space.



Data to be reported to the Secretary General of the United Nations include the name of the launching state(s), identifying data, location and date of launching, orbital data, and the general function of the object.

The 1971 Convention On International Liability for Damage Caused by Space Objects was an even more practical accord stemming from the Outer Space Treaty. As launched objects become more elaborate and sophisticated, and as their size and reentry survivability rises, they have the capability to cause significant damage upon reentry. The Convention deals with liability in these matters and ensures prompt and full compensation for any damage caused by space objects.

Another basic multinational agreement is the 1968 Treaty on the Return of Astronauts and the Return of Objects Launched into Outer Space. This agreement provides for:

☐ Prompt notification to the U.N. by a state of any of its astronauts in trouble.

☐ All possible efforts by states to assist endangered astronauts.

☐ Prompt return of spacecraft personnel who have suffered an accident in another state.

☐ Notification of a launching authority and the U.N. of a space object which has landed in another state or on the high seas.

☐ Notification and elimination of any hazardous or deleterious space object discovered by a state.

☐ Expenses of fulfilling these obligations to be borne by

Managing short-duration space stations will pose thorny legal problems. . . . It is easy to imagine situations in which some legal or medical decision will have to be made on earth, which may be strongly objected to by the affected space station inhabitants.

a launching authority.

Like the Outer Space Treaty this agreement appears truly humanitarian. Underneath, however, one can sense the space powers' fears that astronauts and space objects possessing valuable economic and military secrets could be lost, with no formal legal recourse for retrieving them.

Another important space agreement was the 1972 U.S.-U.S.S.R. Agreement Concerning Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes which was signed in the warm days of détente. Although the agreement included a promise to resolve space-related problems of international law, it was essentially a political statement. This treaty also contained the legal basis for the Apollo-Soyuz Test Project, whereby the two countries aimed ostensibly at developing compatible rendezvous and docking mechanisms to improve space safety and enable future joint missions. It is fair to say that much of the data exchange and cooperation promised in this treaty was a one-way street, with the U.S.S.R. on the receiving end. However, the treaty did at least keep the two superpowers talking.

Besides the treaties discussed so far, a host of other earth-oriented legal regimes also will have to be applied to situations arising in space. Among them are product and contract liability laws, insurance law, tort laws, labor laws and a host of domestic rules and standards (e.g. the Occupational Safety and Health Act).

Suing a Satellite

One particularly thorny problem is how to regulate satellites that can broadcast directly to home television sets, and those that use sophisticated scanners to survey resources of all types on the earth's surface. Both these types of satellites could threaten the sovereign rights of countries. Certainly no country would want another nation's propaganda beaming directly to its citizens' television sets, or for a neighboring nation, say, to know more about that country's mineral deposits or farm production. And, of course, there is the possibility that such "earth resources" satellite data could be quite useful to military planners. These data are quite apart from those yielded by the super-secret satellites already used by the U.S. and Soviet Union to spy upon one another.

Whether various countries can really demand restraints on such satellite technology depends both on how effectively they can punish or defend against transgressors, and how well they argue their case politically, even ideologically. One particularly odd assertion by some "victim" countries has been that there should be a legal distinction between earthward-looking satellites and those that "look away" from our planet. This distinction implies that the Outer Space Treaty allows only the "look-away" variety. The argument almost certainly will not prevail, and in the end some international tribunal will be needed to assure that passive nations are not unfairly intruded upon by others having economically or militarily advantageous satellite data.

One alternative in controlling satellite data would be simply to let it flow freely, forcing nations to cope with this new technology. This has been the trend in the U.S., with N.A.S.A. forging exemplary agreements with Chile, Zaire, Italy, Iran, Brazil, Canada and other nations to obtain and share satellite data about earth resources. In fact, the law establishing N.A.S.A. mandates dissemination of data with few if any restrictions and places upon N.A.S.A. the responsibility to see that the data are applied peacefully. Although N.A.S.A. currently depends on host countries to establish earthbound data-receiving stations, and assumes these countries will not misuse the resulting data, it does retain "turn-off" control over spacecraft and can also acquire its own data if need be. In the future, many more nations will certainly acquire the ability both to launch and support satellites, as well as construct receiving stations.

Ironically the "invasion of sovereignty" issue may be settled by the profit motive. Countries may well continue to expand their satellite programs and peddle remote sensing data until the market is glutted. Perhaps only then will they become sensitive to the have-not nations' arguments about sovereign rights. On the other hand, geographically defined sovereignty of nations will be recognized as a non-viable legal fiction. N.A.S.A. already has set the stage for the profit potential as the dictator of data dissemination. It has inserted certain "cost-related" provisions in its agreements with users of LANDSAT data.

So far, international jurists have focused on the rather parochial issues regarding satellite sensing, such as the need for protection of military and economic secrets. This approach has perhaps obstructed the most important benefits of remote sensing — its forcing of international cooperation.

Martians and the Law

As you have seen, we earthlings have problems enough dealing legalistically with the more mundane, near-earth problems of space exploration. The exotic aspects of space law will present even greater difficulties. For instance, we will have to formulate laws to deal with extraterrestrial life forms. This doesn't mean the bug-eyed intelligent kind from distant star systems; rather the type of lower organic complexes or biovectors we hope to discover free-floating in space or through the recovery techniques of such planetary probes as our future Mars surface sample return missions. We currently have the capability to recover and return a sample of Martian soil. Such a returned sample could introduce into earth's biosphere

an alien life form or toxic substance, either of which might cause an insidious low-grade infection or a catastrophic biological accident. This is a serious risk that must be addressed responsibly, not only by scientists, but also by lawyers.

Laws have been established setting quarantine requirements for known diseases, but there are no laws dealing with unknown diseases. For any known disease there are quarantine protocols which require potential restraint and incarceration of objects and people, but no federal or state government can now legally quarantine a Martian surface sample without the likelihood of violating the "due process" clause of the U.S. Constitution. (This might not be true, however, if it has been determined beforehand that a Martian sample contains an infectious agent, for it would then be a *known* infectious agent.)

In fact, the N.A.S.A. quarantine regulations for Apollo program lunar samples very likely violated the due process clauses of the Constitution. Even the World Health Organization has no recognized jurisdiction to quarantine extraterrestrial biota or contaminants. In the U.S. and internationally, a thorough and complete quarantine protocol must be established to ensure containment not only of Martian samples with potential pathogens, but of extraterrestrial biota from any source. The problems involved are truly international, and to date lawyers seem to have been exceptionally disinterested in the matter.

Legal Complexities of the Space Community

Long-duration or permanent space communities represent the second major or exotic, area of space law. Numerous complex philosophic questions must first be resolved before a successful space culture and legal system can even begin to be established:

☐ Should space societies be considered independent communities or colonies of earthkind?

☐ Should a permanent space community, even though independent from earth, be considered a carrier of earthkind's cultures?

☐ How should we isolate and prepare the most desirable aspects of our cultures for perpetuation in outer space?

☐ Should space inhabitants be treated socially and commercially at arm's length, even though they will initially depend on earth for survival?

☐ Should permanent and independent communities be permitted to establish their own satellite colonies?

☐ What negotiating guidelines should be formulated for earthkind and spacekind?

☐ Will space societies necessitate new economic theory?

☐ Must earth's ecological resources and civilizations be stabilized before long-term extraterrestrial habitats can be supported?

☐ If it is necessary to engineer people genetically for survivability in space, will a *Brave New World* type of structured society be required?

☐ Can space societies be studied to predict social behavior on earth?

☐ What effects will the answers to the above questions regarding spacekind have upon the attitudes of earthkind toward the establishment and evolution of space societies?

Until the second or third generation of space community citizens, there will probably be a wide variety of approaches to these questions. Until then, space cultures and their laws will be shaped purely by economics and technical and physiological capabilities. For example, one basic factor influencing the values and norms of space inhabitants is the physiological stress caused by life-support equipment. The Apollo and Skylab programs have already identified numerous anomalies caused by space travel. "Legal engineers" will have to become familiar with:

☐ The effects of weightlessness on the human body. Such human systems as the vascular and endocrine, which are affected by weightlessness, are the critical components of value-forming processes and ultimate judgements. A stressful situation on earth, which may be a causative factor in a crime, could be taken as "within normal limits" in a space community.

☐ The effects of ambient atmosphere on visual and other sensory systems. The "rules of evidence" could change substantially in space.

☐ Effects of sensory deprivation/overload on all biological systems. Such stresses may surface as aberrant psychological patterns.

☐ Effects of weightlessness on morphology and hematological dynamics.

☐ Creation of anomalous biorhythms resulting in aberrant behavior patterns in a space inhabitant visiting earth. (Would a space colonist be able to claim temporary insanity if he committed a crime on earth?)

☐ Effects of biological variations on normal acceptable behavior standards (or "the reasonable man") set by legal institutions evolving on earth.

One major legal question to be answered is whether a space community inhabitant performing a given function is to be held to a higher level of conduct than a person who performs the same function on earth, where the consequences for improperly performed work may not be so critical. A higher level of conduct might be especially applicable if a space community participant has been selected for certain activity-related, superior genetic and/or physiological characteristics. There undoubtedly will be cases of aberrant behavior due to the environment of the space habitat. The state of a person's entire nervous

A major philosophic question: should space societies be considered independent communities or colonies of earthkind?

system profoundly affects his psychology, and thus his conduct, and the space habitat may well impose conditions alien to earth life-forms such as ourselves.

One possible answer to the need for higher or different standards of acceptable conduct occurring in space is to write such standards into premission business or employment contracts, which would also affect the applicability of various types of space insurance offered by private or public companies.

The successful operation of a space community may also require genetic engineering — ranging from direct genetic intervention to eugenics counseling — as well as drugs to create or control space community behavior. For example, drugs might be used to block undesirable sexual attitudes or memories of traumatic experiences. All these social and biological possibilities raise definite legal problems.

Besides the broad philosophic issues discussed above, a number of practical legal problems have already become evident, even in these early stages of space law. A number of such problems were outlined in a September, 1970, N.A.S.A. workshop at Ames Research Center. For example, space habitats may be used for either research and development or practical applications such as commercial space manufacturing. This duality will probably create management difficulties due to the different characteristics of the people required for these two activities. One may recall that serious dissensions arose in N.A.S.A.'s astronaut corps when the scientist-astronauts questioned the need or desirability of the pilot-astronauts in the program.

Also, many experiments in space will not require the investigator to be present, but can be carried out by a technician following a "recipe." So, at least at the outset, most work in space likely will be done by professional, experienced crews, hired on a competitive basis. There will have to be specific bodies of labor and corporate law spelling out crew performance standards, rights and responsibilities.

Managing short duration space stations will pose thorny legal issues, especially if the manager is physically located on earth. It is easy to imagine situations in which some legal or medical decision will have to be made on earth, which may be strongly objected to by the affected space station inhabitants.

Another practical problem would be how to govern a space society inhabiting a "cluster" of interconnected modules built and maintained by individual nations or other institutions. The 1970 N.A.S.A. workshop held that the operations of such modules will be subject to the same principles. However, it is difficult to imagine a high degree of cooperation between interconnected modules staffed by alien cultural representatives. There could be

No federal or state government can now legally quarantine a Martian surface sample without the likelihood of violating the "due process" clause of the U.S. Constitution.

controlling multilateral agreements that would have to be signed by each country whose citizens occupy a cluster module. But such agreements would only dodge the basic problem of whose laws will control the commonly shared needs of the cluster module as a unit. It will probably turn out that, since each participating nation's laws will have to respond to that nation's own cultural background, each module will have its own set of laws, and any blanket agreement would cover only "housekeeping" rules. So, if an American astronaut entered a Soviet module in a space station, for example, he would be subject to Soviet laws, as would a Soviet astronaut visiting a U.S. module be covered by American law. This would be much as conflicts of laws and jurisdictional problems are currently handled in the international community.

A "Magna Carta" for Space Communities

Space habitats will and should be places of social and political experimentation, for they are unique and synthetic life-support environments, requiring adjustments to the evolution of new, and very likely alien, social values. To cultivate such disciplined experimentation, I have proposed an international convention governing the conduct of spacekind and earthkind:

First, the exploration and use of outer space, including all celestial bodies accessible by man, should be carried out for the benefit of both earth inhabitants and the explorers and settlers of space. Such areas of habitation should be considered first as the province of spacekind, and second of earthkind.

Inhabitants of outer space or celestial bodies should not be subject to national sovereignty or citizenship, but should be politically and culturally independent.

Signatories to this convention should observe international law pertaining to human rights in their relationships with each other and with spacekind.

Although military personnel can be used for scientific research or any other peaceful purposes in interactions with space communities, there should be no bilateral or regional military relationships with space communities.

Each signatory state should be responsible for its own national space activities that may affect space communities. For instance, outer space research conducted by the individual nations should not damage the ecosystems or cultural integrity of a space community.

To ensure the peaceful intents embodied in this convention, each signatory state should allow its space communities to be examined for cultural independence and non-military alignment with other signatory states. However, such examination should not occur as a matter of right beyond the second generation born in any space community, at which time the inhabitants should be considered to be truly indigenous and independent "spacekind" who are no longer wards of earth civilizations.

Signatories should agree to the establishment of an expert organization under the U.N. or other international body. This organization would provide an academy of behavioral scientists to review the relationships between mankind and spacekind. It would also refer cases at issue to the International Court of Justice.

In this broad-brush review of space law, I've admittedly been more provocative than informative, but I think I have fairly represented the sketchy, theoretical as well as hard-case, facets of space law today. It is well past the time for the legal profession to begin exercising a disciplined imagination to establish engineered legal systems for a biomedically engineered society in a totally engineered synthetic environment in outer space.

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The State of Our Mineral Position: A Provocation

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Minerals are fundamental necessities of a modern technological society. But no one of them merits exception from the rules of the marketplace.

The purpose of this article is to provoke.

Provocation 1: The market system does not, and can not, effectively and efficiently allocate mineral resources at a point in time, or over time. There are characteristics on both the supply and demand sides of mineral resources that have critical impact on the effectiveness of the market system as an allocator of these resources.

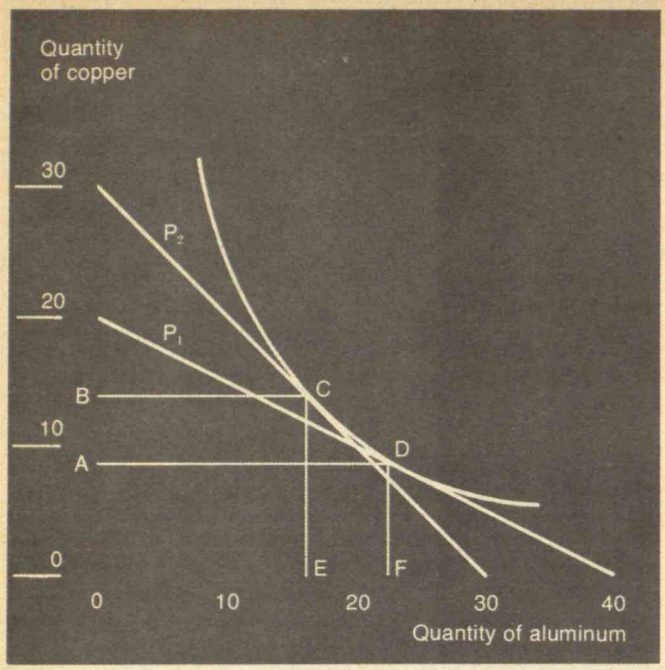
To summarize for those readers who are not economists: the market system allocates resources through pricing to permit those who want a commodity and will pay for it to obtain that commodity from those who are willing to supply it. The priority of use is established by the willingness of the consumer to pay. A hierarchy of suppliers is established by the efficiency, measured in costs, of those who wish to supply the commodity. Those consumers who are not willing to pay at least the going price for the commodity do not receive it. Those producers who cannot produce the commodity to sell at going prices do not produce it. Thus, producers and consumers are determined through the automatic operation of the market system.

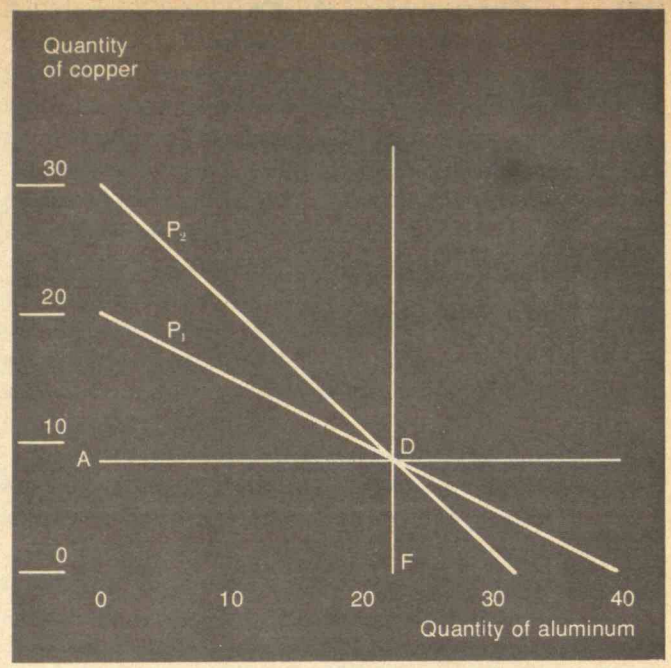
The operation of this system in mineral resources is imperfect and inefficient on both the demand and supply sides. The short-run situation for both demand and supply of mineral resources is such that the market adjusts primarily through price movements, not by changes in the quantity supplied or demanded. This is true because of the following characteristics inherent in mineral demand and supply.

With trivial exceptions, minerals are not demanded as such. The consumer does not demand iron ore. He buys a dishwasher, an automobile, or a can of vegetables, each of which uses a material based on iron ore. The demand for iron ore is dependent upon the technology involved in the production of the good bought by the consumer. In general, even an order-of-magnitude change in mineral prices will have greatly diminished impact on the final price of the consumer good. From the consumer's point of view, then, mineral prices do not significantly affect his decision to buy.

But in conventional economic thought, the manufacturers of the consumer product and the producers of the raw materials sold to the manufacturer are highly sensitive to price. Therefore, the reasoning goes, the market system, while not allocating minerals at the final consumer level, operates efficiently and effectively at the producer level. This argument overlooks the fact that technologies by which minerals are used at the producer level are also insensitive to the kind of marginal adjustments presumed for the market system. There are two major reasons:

☐ Mineral costs are likely to be a small portion of the total cost for the manufacturer of consumer goods; for example, the inter-industry flow data of the Department of Commerce tell us that primary minerals are but 3 per cent of the inputs to new construction, 0.3 per cent of food products, 1.1 per cent of household appliances, and 0.9 per cent of automobiles. The manufacturer will choose the lowest-cost technology emphasizing, for example, the way a part can be fitted into the styling and assembly processes rather than the cost of the raw material basic to the part.





These two charts illustrate the responses to price before and after a technology establishes the pattern of material consumption. The chart at the left is the case before the technology is fixed. The curve represents the technically possible combinations of copper and aluminum, for example, which could be used to produce a hypothetical product. Before the technological decision is made, any combination on the curve can be considered. If the expected price of one pound of copper is equal to the expected price of two pounds of aluminum (line P1), the producer would, to minimize costs, use aluminum and copper in the ratio of OF to OA; this is determined by the point on the curve which has the same slope as the price line P1, which is the point corresponding to the least cost of material possible for the given output. If the cost of one pound of copper is expected to be the same as that of one pound of aluminum, then equal amounts of copper and aluminum would be used (OB = OE). The chart at the right illustrates the situation after the technology is fixed on the basis of the first hypothesized expected prices. There is no longer an opportunity to shift material consumption on as prices change; the ratio of materials is fixed — OA copper and OF aluminum.

□ The technology chosen by a producer is built around specific characteristics of specific materials, and substitution between materials in response to price changes is extremely slow, expensive, and discontinuous. This point is illustrated by the charts above which represent a classic case of inelastic demand, where demand for a product is relatively constant despite changes in price. Other examples of demand inelasticity because of technology commitment can be illustrated at the consumer level: once a house with electric heat is purchased, how much will the price of electricity have to change before the homeowner will change to a heating system based on a different fuel? How high will the price of gasoline have to rise to generate substantial shifts to diesel or electric cars or to alternative forms of transport?

In summary, the short-run demand for minerals in significant market areas is highly inelastic: large changes in price exert no significant rationing function on demand.

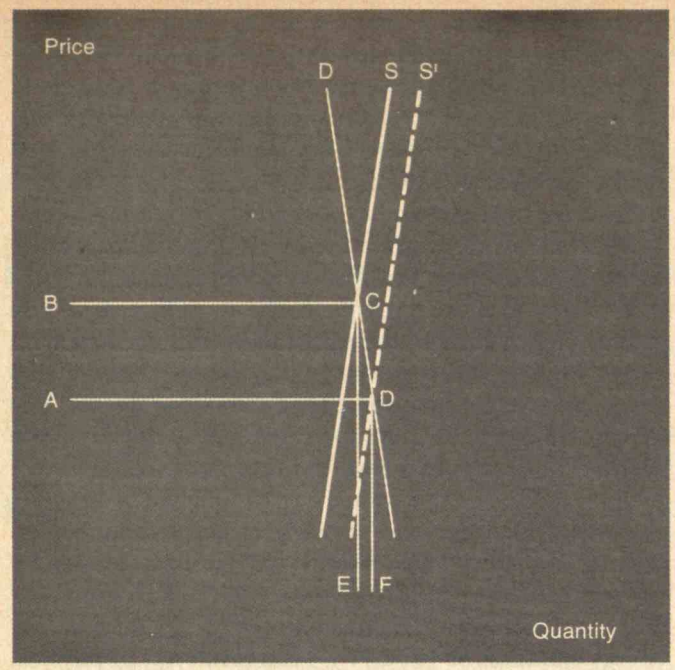
Minerals come from the exploitation of known and developed resources, from the exploitation of known but undeveloped resources, and from the discovery of new resources. In the short run, supply is limited to the capacity of the known and developed resources. Mining is capital-intensive, and capacity is designed to avoid high unit costs. Therefore, the supply response to higher prices is very inelastic in the short run; that is, production can change but little in response to rising price. Supply is also highly inelastic to price declines because there is a large component of fixed cost in the production of minerals: a deposit will continue to be produced even if price is falling, so long as out-of-pocket costs are covered.

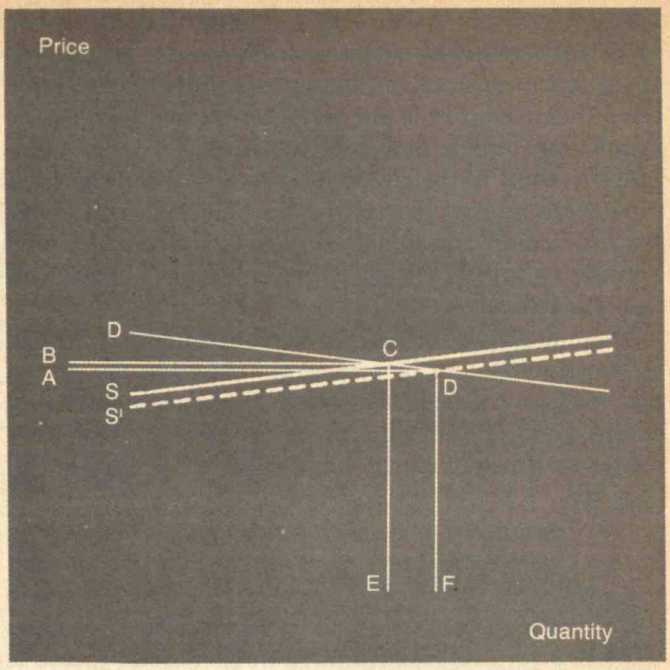
Highly inelastic supply functions, combined with highly inelastic demand functions, give a market result illustrated in the charts on p. 67. Changes in the market are reflected largely in price, not quantity, adjustments.

Considering a time period long enough to permit new investments to bring forth new supply and for consumers of minerals to change technologies, the situation is somewhat different. On the demand side, higher prices for a given mineral will tend to cause producers to seek substitute materials and production methods which over time, on an incremental basis, will reduce the per unit consumption of the expensive mineral. Similarly, on the supply side, higher prices will tend to bring into production known deposits which were marginal under the lower price structure, and they will also tend to increase the rate of discovery. Unfortunately, the very volatile nature of many mineral prices, because of short-run market situations, mitigates against the effective operation of these forces in the long term. Such short-run price behavior greatly increases uncertainty and masks the market signals to decisionmakers.

Imperfection in the short-run markets leads to misallocation and ineffectiveness in the long-term markets. The short-run imperfection in markets is the basis for Provocation 1.

Provocation 2: The current institutional structure does not provide adequate incentives for technological ad-





The behavior of the free market system — somewhat idealized — is described by these charts. Price and quantity are determined in free markets by the intersection of the supply (S) and demand (D) curves; price is established when the quantity supplied equals the quantity demanded. The chart at the left portrays the situation in an inelastic market, in which even a large change in price leads to only a small change in demand and hence in quantity; the chart on the right shows an elastic market function in which small price changes result in large changes in quantity.

vance in the raw-materials-producing industries. It has been the conventional wisdom of the doomsday purveyors from Malthus through the Club of Rome that resource scarcity will limit economic growth. In contrast, it has been the conventional wisdom of countless economists that technological progress will offset the diminishing returns to resources. At least until the early 1960s the economists carried the day. Since that time, the record has become unclear. The real prices of raw materials appear to be rising. Many learned reports have used such measures as the numbers of students enrolled in engineering, the numbers of patents issued, and other indirect indicators to show a decline in the rate of invention and innovation — that is, a decline in technological progress — in the mineral industries. Technological progress that makes possible exponential growth in the use of minerals through the exploitation of the exponentially increasing resources of lower and lower grade appears to some scholars to have ground to a halt.

Our current institutional structure is not providing incentives sufficient to continue the historic trend of increasing technological progress in the raw materials sector. The reasons for this are many and complex and — admittedly — not fully understood.

First, any raw material company desiring to increase productive capacity has three alternatives:

☐ Technological innovation to make feasible the exploitation of known high-cost deposits;

☐ The development of increased capacity for recovery from currently mined deposits; and/or

☐ Exploration to develop new sources producible by available technology.

Since World War II, exploration for new resources on a worldwide scale has become a preferred alternative to innovation seeking to make possible more intensive use of known, but submarginal, deposits. This was because major areas of the world were for the first time opened to exploration (under varying conditions of extra incentives) in the 1950s, and the trend was strengthened by the stability of international capital markets after World War II. The incentive for exploration is now becoming even stronger. Many host countries are receptive; tariffs on minerals are low; international capital markets readily finance foreign investments; there have been quantum decreases in ocean transportation costs; and rapid industrialization is providing alternative markets for minerals discovered overseas. Thus most available capital resources are now devoted to exploration rather than to research and development.

Second, the demand elasticities mentioned above mitigate against investment in innovation whose goal is to keep the real cost of minerals low. This is because producers know that increases in costs can be passed on to the purchaser of the material without danger to profit margins. Such increased costs automatically increase the rents associated with new discoveries, and thus they reinforce the tendency noted above toward exploration.

Third, technological improvements in mining are generally not protectable by patent, and the advantage of such improvements to an individual company are quickly dissipated by their adoption on a worldwide basis. The fragmentation of the industry (for example, mining companies are not the companies that develop mining methods) increases the problem of the innovator who seeks to capture the returns from his innovation.

It's interesting to note in this regard that much of the major innovation in the minerals sector since World War II has been the result of public, not private, research and

development. The technology for using taconite flowed from pioneering studies by the U.S. Bureau of Mines. The development of uranium mining and processing to serve the nuclear industry is the result of expenditures by the Manhattan Project and later the Atomic Energy Commission. Most of the research on recycling and the reuse of minerals is under federal auspices. The major programs for gasification and liquefaction of coal are under government contracts. The development of oil shale technology was federally financed.

There has, of course, been continued improvement in technology financed by private industry, but the rate of this progress has been very slow. This is because our institutions do not offer incentives for technological innovation by private industry engaged in the production of minerals.

Provocation 3: The current institutional structure does not provide adequate incentives for the wise and efficient use of mineral resources. Consumers of goods demand qualities which are wasteful of resources. Many examples may be cited. Disposable bottles are preferred because of the cost and inconvenience of returning bottles to the store. The extra cost of plastic wrapping of small consumer items at the retail level is offset by the economies of better inventory control and less loss to shoplifting and handling; but such practices are profligate in their use of raw materials. Consider, for example, the difference in raw material requirements between the sale of a package of five nuts and bolts, wrapped in a 4-by-5-inch square of cardboard with an insert of a hard plastic, and those same five nuts and bolts sold out of a large bin which may even have been a shipping carton for hundreds of these items.

The companies which sell minerals have an interest in selling more, irrespective of whether or not the sales will lead to applications where the particular materials will have a clear comparative advantage. Since price plays such a small role in the allocation of mineral resources, characteristics such as convenience and aesthetic qualities are appealing in the marketplace.

In short, our system encourages profligate use — not efficiency.

Provocation 4: The cost of mineral resources will increase very substantially, in real monetary terms, over the next decades. This conclusion flows from the imperfections in market systems and institutional arrangements listed in the first three Provocations; and it comes also from the fact that many of the real costs involved in present mineral production and consumption will be paid in the future. Mineral users are only now beginning to pay the costs of such externalities as land damage, water and air pollution, and risk to the health and safety of working populations.

For example, the productivity of workers in coal mines has drastically declined since 1970 as a result of our new insistence on protecting the health and safety of miners. Substantially higher electric rates in the eastern metropolitan areas result from the requirement to use low-sulfur fuels for the generation of power. Anti-pollution devices result in higher costs per mile of automobile travel. Even if the real costs of minerals themselves do not increase, our belated efforts to account for these external factors assure that the use of minerals will be more costly in the future than in the past.

Provocation 5: In spite of Provocations 1 through 4, we do not face, in a fundamental sense, a crisis in our mineral resource position. I am confident that this is so for two classes of reasons.

First, the immense and exponentially increasing capital stock available to us provides a very powerful capability for problem-solving and for overcoming temporary obstacles to continued growth. If the metallurgists, those master French chefs of the materials world, are denied an exotic spice — say, tungsten — they can still brew a very acceptable recipe using something else — say, boron. The product may not be quite the same, but it will fulfill the fundamental purpose for which the brew was cooked. We may confidently expect that our exponentially growing stock of knowledge and of physical and human capital will be sufficient to overcome any problem raised by natural resource scarcity. We may in fact be confident that any shortage that actually occurs — such as the energy situation of 1976-77 — is a result not of physical scarcity but of institutional failures. Just as the creation of the shortage is a function of man, so its alleviation is similarly within his competence.

Second, resource costs are no longer very important to our economy. The proportion of Gross National Product spent for natural resources has been declining, and it now is only 6 per cent in spite of the large increases in fuel prices since 1973. The *increment* of growth in G.N.P. in 1976 will be about $173 billion; but the *total* value of primary minerals used in the United States for 1976 was on the order of only $90 billion. In the aggregate, increased primary mineral costs do not matter.

To avoid long-run mineral scarcity, and to prevent temporary shortages in supplies, we must redesign our institutions in the mineral raw materials area. Where markets can be made to work they should be used. Where they cannot work, alternatives should be developed.

My purpose is to provoke. Provocation is useful and productive only if it creates reaction. I had hoped that the President's Materials Policy Commission would address the hypotheses implicit in these provocations (which I laid before them) and would point to policies and actions which would correct any found deficiencies in our current institutions and ways of doing things. Their final report did not address these issues, and the final report of the National Commission on Supplies and Shortages takes only small notice of them. Public discussion remains the tool for forcing redesign of our institutions. Perhaps this article will at least help to start such discussion.

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Radical Chic

The Age of Uncertainty
John Kenneth Galbraith
Boston: Houghton Mifflin Co.,
365 pp.; $15.95

Reviewed by Jeffrey L. Lant

My first and only personal encounter with John Kenneth Galbraith occurred at the Harvard Commencement of 1970, when I was receiving my Master's degree.

I had refused to participate in the graduation ceremonies for my B.A. degree the year before (my one concession to the revolution which was then pending), and had in consequence grieved and irritated my mother inordinately. So I agreed to march in the Yard the next year, even though I had been all-too-solemnly informed by several senior colleagues that the protocol for serious graduate students was to wait until their Ph.D. was awarded before donning academic garb.

Thus, a mother's wishes easily triumphed over the demands of what seemed even then spurious tradition. As a result, she traversed the entire continent, coming from Los Angeles to see that I did not lapse.

Having made the journey — her first to Cambridge — she was utterly and predictably determined to see the full range of Harvard's riches, including whenever possible the brightest of the university's professional luminaries. Moreover, being a zealous amateur photographer, she was determined to capture the entire experience on film.

Which brings me to my remembrance of John Kenneth Galbraith.

At the conclusion of the Commencement exercises, my mother spent a happy and hectic period searching the Yard for departing celebrities with her rather abashed son firmly in train.

One of those she bagged was Professor Galbraith.

"Go up and ask him if he'd mind having his picture taken with you," she commanded.

Though I am not unusually timid, I faltered at fulfilling this request. Instead, I meekly went up to the great man and, hoping that he might sympathize with those who had to cope with mothers at commencement time, asked if mine could take his photograph — alone.

My mother, of course, was not entirely pleased by my scaled-down request, but I shall never forget Professor Galbraith's reaction: he was utterly disgusted, stopping long enough on the steps of Widener Library, however, to let her proceed.

It was in this way that she came to take a photograph I now (perhaps wrongly) think entirely characteristic of the man: tall, slouching, his face well-lined and drawn, staring out at the world (and as I so well remember, at us) with an expression at once bored, indifferent and not a little hostile, thus indicating that his time should never have been requested for so trivial an undertaking.

The matter concluded (not a moment too soon for either his or my taste), he slowly mounted the library's wide steps, moved upwards under the crimson marquee, and so disappeared into Widener's recesses to mix (more graciously, I hope) with his peers.

The entire encounter took less than a minute, but it left an indelible impression upon me, an impression which has been strongly reinforced by reading *The Age of Uncertainty*.

Cat Among the Pigeons

The book surveys — with Olympian detachment — some of the leading economic movements and ideas of western society since the Industrial Revolution. (Though like the gods of Olympus, Professor Galbraith has occasionally condescended to participate in mundane, human affairs such as the determination of World War II price controls and the 1960 Democratic convention.)

It is rather like setting a cat among the pigeons. And predictably, many pigeons go to a death at once bloody and premature.

Among the victims of Galbraith's mordant and often deeply-ironic reflections are "tough, down-to-earth" 19th-century industrial managers who opposed child labor reforms, so as to "get a day's work out of the little bastards," and squabbling idealists, "including liberal reformers in our own time," who often feel that "everything should be sacrificed to a good row over first principles or a fight to the finish over who, if anyone, is to be in charge."

Others who meet the lash are American university presidents, who "are paid above scale to suffer for the free expression of the less convenient members of the faculty, but rarely believe they should have to earn their pay," and agents of the C.I.A. at the time of the Bay of Pig invasion, who "had been [so] well brought up in good families, had gone to good schools and been hired on the basis of character and intelligence, [that] they were without experience in sustainable mendacity."

There is, however, a good deal more to this book than the witty, irreverent, and indeed illuminating comments on society's cherished ideas and on the lordly panjandrums who express and even believe them.

Illustration: Courtesy of the B.B.C.

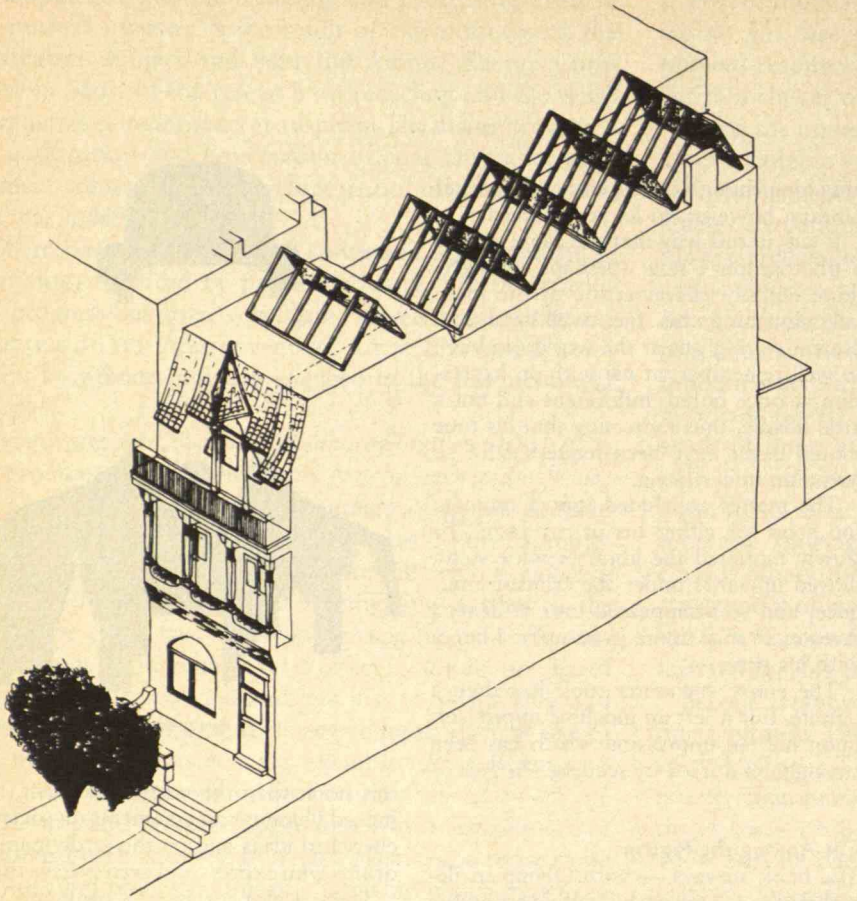
There is, for instance, a profound recognition that leaders and their ideas are less powerful than they believe, or we admit. "For in economic affairs decisions are influenced not only by ideas and by vested economic interest. They are also subject to the tyranny of circumstance. This, too, is severe. . . . We do not see that, very often, circumstances close in and force the same action on all — or on all who are concerned to survive."

Even so, Professor Galbraith maintains, the force of circumstance is not so strong that individuals are powerless to effect change. Quite the reverse, in fact. "The problem, all but invariably, is on confronting [the range of social problems]. Few, if any, are difficult of solution. We know what needs to be done; for reasons of inertia, pecuniary interest, passion or ignorance, we do not wish to say so."

Commitment and Act

What does Professor Galbraith think needs to be done? He advocates such reforms as income for the poor, "whether in the form of food, housing, health services, education or money," economic controls to avoid both unemployment and inflation, and confrontation with the great nuclear truth: that no society — neither western nor Communist — will survive an atomic blast and that the elimination of the threat "is now the supreme test of our politics."

Who can deny the importance of these goals, or the fact that they should be urged upon a wide public? Professor Galbraith is



3920 Spruce Street in Philadelphia is being retrofitted for solar heating to demonstrate the practicality and feasibility of using solar energy for row houses. Row houses are frequently owned or occupied by the lower to middle income families most hurt by rising energy costs. The renovation is part of a project on energy conservation in housing construction conducted by John A. Lepore, Noam Lior, and Sidney Shore of the University of Pennsylvania. (Drawing: American Society of Civil Engineers)

contributing to their public acceptance through this book, and through the B.B.C. television series of the same name which he has narrated.

But it is no longer enough merely to recommend what might be done to improve society. We must do more than identify problems and profess our good intentions for their solutions. We must act.

And here Professor Galbraith fails us, for all his wit and wisdom. No longer in the forefront of reformers — even though he says his "bottom bears a permanent latticework design from the chairs" of all the conventions and meetings he's attended — he is open to the charge of being no more than an armchair socialist: ideologically left, financially ensconced solidly on the right, comfortable with his millions and his skiing sessions in Gnaad with members of the Kennedy Camelot crew.

But that, of course, is the way with so many "reformers" who are strenuous on behalf of "the people" until it comes time to do more than speak up for them. Humanitarian in word, their deeds are somewhat less substantial.

Perhaps I do Professor Galbraith an injustice, but his book does a good deal to sustain the charge. Written with a verve and fluency that would make any literary gent proud — much less an economist, eminently readable, full of wise observations and telling points, this is still the book of a man detached from people: dubious about their fates, to be sure, but not particularly involved with them. And it is this evident detachment — not from man's fate but from the men themselves — that makes me most uneasy.

Jeffrey L. Lant, with a Ph.D. in History from Harvard, is Coordinator of Student Services in the Evening College of Boston College. He has been instrumental in promoting reformist legislation in the Massachusetts General Court involving secondary education and young adult unemployment. □

Energy on Beam

Solar Heated Buildings: A Brief Survey
13th (and final) edition
William A. Shurcliff
Cambridge: W. A. Shurcliff, 19 Appleton Street. 1977, 306 pp.; $14

Reviewed by William Barton

The title is reminiscent of *The Last Whole Earth Catalog,* but the author explains that the number of solar heated buildings is increasing so fast, and that duplicate designs are becoming so common, that a future comprehensive survey would be too long and, in spots, too boring. Such concern for readers deserves our gratitude, but thanks to the inclusion — for the first time — of 80 photographs of solar heated buildings, there is no danger of boredom. We are thus provided with a glimpse of the architectural expression which solar heating is receiving in various regions of the country that may lead to a new emphasis on vernacular architectural styles.

Do-It-Yourself Energy

At a recent forum on solar energy, Hoyt C. Hottel, Professor Emeritus of Chemical Engineering at M.I.T., reported that he was unaware of any new technological breakthroughs in collector design. He suggested that solar heating might best be put to work by "blue collar workers" who, unlike college professors, would rather work with their hands than read books. The economic advantages of this do-it-yourself approach could be impressive. At present, the average cost of solar collectors is about $20 per square foot, according to the Federal Energy Administration book, *Buying Solar.* Professor Hottel thinks the manufacturer's markup on the equipment may be as high as 100 per cent, to which must be added 25 per cent for the contractor who provides and installs the components.

As a result, except for experimental and research-oriented projects, there is ample evidence that major interest in solar heating is still confined to wealthy clients. Of Mr. Shurcliff's 100 new entries in this edition, 40 per cent involve architectural and engineering consultants, while private owner-builders account for another 30 per cent, and the remaining 30 per cent have research funding. Mr. Shurcliff finds that the most cost effective systems were not funded by government grants. Thus he laments the fact that the "lone wolf inventors who pioneered major advances toward simplicity and low cost are not being helped." (Those who have tried to obtain government grants or commissions know that lone wolf inventors have about as much chance for funding as ice cubes in hell.)

Solutions for solar heating vary with

each region. For example, we should expect air-type collectors to predominate in colder climates where liquid-type collectors might freeze. Air-type collectors are ideal in desert climates where evaporative cooling is made possible by low humidity. Liquid collectors seem to be more promising in southern climates, where the potential exists for a cooling cycle using heat pumps. Although liquid collectors are found in all regions, they are plagued by control disfunction, the use of antifreeze additives, and corrosion. The inherent advantages of water over air for heat storage appear to be offset by these problems; for some areas of the country, such as the Northeast, it is an open question which type of collector will prove most satisfactory.

For a surprising number of projects, solar heating systems appear to be an afterthought to architectural design. Those projects which integrate the solar heating system with passive heating design come off best visually. For example, the Richards house in Jamestown, R.I., places all windows to the south, carries up the concrete foundation wall to the roof line on its other exposures, and is also dug into the ground on its north exposure. Another example is the Terry house in Santa Fe, N.M., which steps down a slope and uses repeating elements for the collector design. The design is further enhanced by solid walls which are rounded at the corners, giving the building an aerodynamic quality that is in keeping with traditional adobe buildings in the area.

Solar Off the Shelf

Successive editions of the *Survey* have contributed to our growing awareness of the advantages of solar heating, an awareness made inevitable, perhaps, by the 1973 oil embargo. But if the general interest in solar power is to be translated into action, a number of problems must be resolved. For instance:

☐ *Retrofitting.* According to the Energy Research and Development Administration, over 18 million houses require insulation. For years, many beautiful, old houses have been destroyed, or are slowly deteriorating as a result of the deposit of loose insulation in the exterior walls. If these buildings are to be solar heated, they must be insulated more effectively. Even then neighboring trees and structures may pose insoluble barriers to the collection of sunlight during critical months of the year. A very high percentage of existing housing will be abandoned if the cost of conventional energy should indefinitely grow faster than other costs in the economy.

☐ *Performance standards.* Manufacturers' claims for their products are often inflated or misleading. There is confusion in the variety of ways in which performance data are expressed. For instance, most of us will need to be told how to convert the Weather Bureau's langleys to B.t.u.s for a given month and location.

☐ *Marketing.* Architects are involved in only 5 per cent of new houses, and consulting engineers are called upon perhaps even less often. So if we are to increase significantly the number of solar heating systems, pre-engineered, off-the-shelf systems must be manufactured that tradesmen and local heating and ventilating contractors can install and guarantee.

☐ *System failure.* There is great danger that the current healthy interest in solar energy might slacken if failure rates are not reduced drastically. If the nation should lose interest in solar heating just when the need becomes critical, then the chance for an orderly transition to solar will be lost. We need to monitor existing systems (Mr. Shurcliff has files on 800 of them) in order to improve reliability.

Only the salesmen are saying that these technical problems have been solved. They will require extensive study and monitoring if solar energy is to become a realistic alternative in building design. Such study is particularly essential for New England, where natural gas and electricity rates are twice the national average, and rising.

William Barton is a graduate of the Harvard University School of Design and a registered architect, practicing in the Boston area. ☐

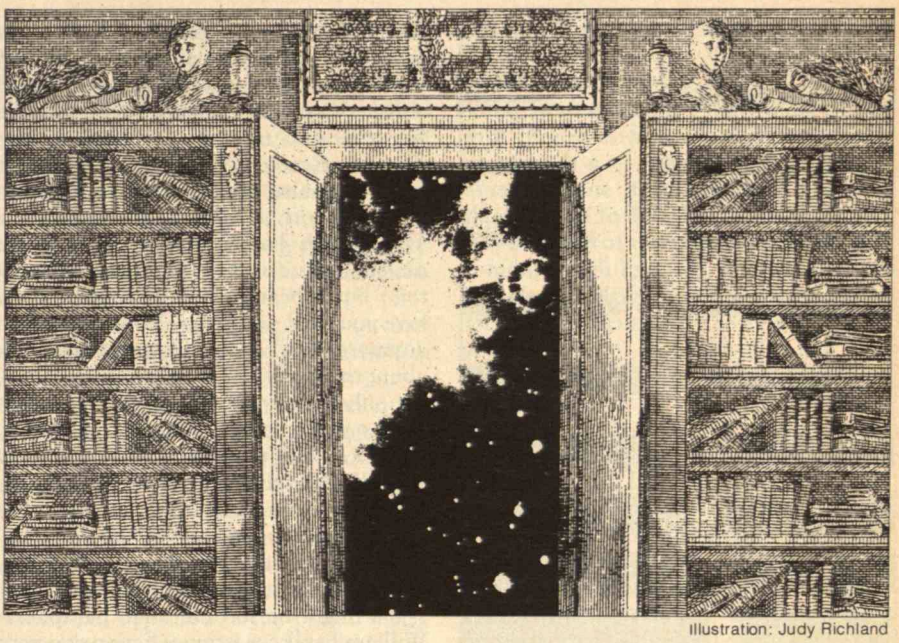


Illustration: Judy Richland

If

Turning Points: Essays on the Art of Science Fiction
Damon Knight, ed.
Harper & Row, 1977; 303 pp., $12.50
Science Fiction: Today and Tomorrow
Reginald Bretnor, ed.
Harper & Row, 1974; 340 pp., $8.95
The Craft of Science Fiction: A Symposium on Writing Science Fiction and Science Fantasy
Reginald Bretnor, ed.
Harper & Row, 1976; 320 pp., $8.95

Reviewed by Daniel Dern

Literature — fiction, stories, prose, what have you — is supposed to reflect the world and in some ways help us to make sense of it. However, in these exponential times anything written about *today* is likely to pertain only to *yesterday* by the time it has passed from author to bookstore — and often the ms. is dated as the last page is plucked from the typewriter.

Science fiction, whatever its literary sins may be, is the only literature extant which prepares us for what is to come. Not that s.f. (pronounced "ess eff" — the phrase "sci-fi" is abhorred within the field) predicts the future in particular. No s.f. writer lays claim to prophecy, but those who read, write, and teach science fiction live with the knowledge that tomorrow will be different from today. (Ray Bradbury, author of *The Martian Chronicles, R Is For Rocket* and other s.f. works, provides some insight: "Science fiction doesn't

predict the future — science fiction *prevents* the future."

In his essay in *Science Fiction: Today And Tomorrow*, Thomas Scortia points out that s.f. provides us with a useful form of *gedankenexperiment* — a thought experiment. The R.A.N.D. studies, Pentagon war games, and Club of Rome graphs provide good bare bones to cast and read the future from. Through the medium of fiction, if the author is skilled in the disciplines required, the intensifiers "What if?" and "If this goes on. . ." can be applied to any situation — any, not just the probable — and so we peek into the maybe-futures to see what they might be like. How will we greet our first visitors from the stars; what will life be like after the holocaust of World War III; will practical organ transplants lead to new types of crime — and punishment? I will not claim that *all* s.f. performs this task — or even that all of that portion which tries, succeeds — but imagining the myriad futures, be they ten seconds or ten millenia away, accounts for a significant clump of the science fiction written.

What *is* science fiction? More important, what is s.f. that other literature is not? Every discussion of s.f. must anchor itself to some definition, new or old, which is particularly despairing since there is no one accepted definition. There are pragmatic definitions — "Science fiction is whatever we are pointing at when we say science fiction" (Damon Knight) and ". . . anything published as science fiction" (Norman Spinrad). There are definitions by intent — "Science fiction is a way of looking at the world" (Fred Pohl) and "Science fiction is the literature of change" (Ben Bova, current editor of *Analog*). There are many precise definitions, too long to quote here; obviously, you should read one or more of the books which sparked this discussion if you're really curious.

But as Theodore Sturgeon has pointed out in one of his many acute analyses of s.f., "The original meaning of the word *science* is *knowledge*. Science fiction is *knowledge fiction*. What you say is the science part; how you say it is the fiction part. If you can extract the science — knowledge — aspect and still have a cohesive fiction, it is not s.f."

In other words, it is not the depth of the author's scientific research, or the feasibility of his/her speculations, or even the plausibility of whatever arcane assumptions underly the story that place a story in the realm of s.f. These merely affect the *quality* of the work. It is the Idea, the thinking the author has done which makes a story science fiction. In the words of Barry Malzberg, author of *Beyond Apollo*, "Even the stupidest most terribly written s.f. story is still about *something*."

Kurt Vonnegut expands on this point in his otherwise non-s.f. novel, *God Bless You, Mr. Rosewater*. In a drunken speech his protagonist, Eliot Rosewater, makes to a convention of science fiction writers. This speech has been quoted to death already (twice in *SF Today and Tomorrow)* but it bears one more repetition: "I love you sons of bitches. You're all I read anymore. You're the only ones who'll talk about the *really* terrific changes going on, the only ones crazy enough to know that life is a space voyage, and not a short one, either . . . You're the only ones with guts to *really* care about the future, who *really* notice what machines do to us, what wars do to us, what cities do to us, what tremendous misunderstandings, mistakes, accidents and catastrophes do to us . . ."

If I might be so bold as to paraphrase William Faulkner, science fiction concerns the intersection of knowledge and the human heart. Or even: Science fiction speculates on the impact of knowledge on the human condition. Not all s.f. to be sure — for, as Mr. Sturgeon observes, "Ninety per cent of science fiction — like everything else — is shit." But enough s.f. is good, enough looks at today and attempts to view tomorrow, to give cause to read the stuff besides the usual excuse of enjoyment.

An S.F. Course for Every Discipline

I wanted to take a literature course in science fiction during my senior year at M.I.T. One would think that here of all places such a course would be offered. After all, at least one third of the student body reads s.f. regularly (and it is likely that some students read no other non-course fiction). The M.I.T. Science Fiction Society owns the largest private collection of s.f. in the country. And I have no doubt that many of the science and engineering faculties read s.f.

Yet, in 1972, no such course was offered. Further, many of the Literature Department professors considered s.f. a subliterary genre on a par with mysteries and westerns — so far beneath their interest that they had never read any.

Well, to make a long story brief, *I* taught the course: *21:922: Science Fiction — What Is It And Why Do We Read It?* Ah, sweet victory. I'm sure the course was superficial and unfocused and more, but we all had a good time. And did learn some. (I discovered that you can't teach a survey of the entire width, breadth and history of s.f. in one semester; you can only outline the subject matter.)

But another interesting question arises now: why the Literature Department? Certainly that's a legitimate home for such courses: if you're studying the literary aspects of s.f.; development of styles, schools, authors, etc.; how to write it, edit it, sell it. But what if you're studying planet-building? Or sentient computers? How to design hospitals for 8ft.-tall chlorine-breathing lobsters? The philosophic questions of original sin in extraterrestrial species? Are we still in the Lit. Department? On the contrary, we have one foot in each and every field (assuming enough pedal extremities), all with valid justifications for their presence.

These three books clearly illustrate the fact that everyone involved in science fiction writing *cares*. Writers, readers, editors — everyone has opinions, criticisms, suggestions, ideas. In addition to the furious activity generated by this interest — conventions, bookstores, amateur magazines, clubs, etc. — a great number of s.f. writers have examined their own works and methods, and those of their colleagues, in essays both informative and enjoyable. Written for newcomer and habitué alike, these essays illuminate various aspects of science fiction, and provoke new areas of inquiry. A random selection of titles from the three books at hand: "How To Build A Planet" (Poul Anderson), "There's Nothing Like A Good Foundation" (Isaac Asimov), "Gourmet Dining In Outer Space" (Alfred Bester), "Science Fiction, Morals and Religion" (Theodore Sturgeon), and "Hitch Your Dragon To A Star — Romance And Glamour In Science Fiction" (Anne McCaffrey).

The Knight and two Bretnor collections each contain a good double handful of essays by people who know what they are talking about, and say it agreeably. I might recommend that a newcomer to s.f. try the Knight book first, but the choice is close. All three books are interesting and informative. There is little duplication among the volumes so you could conceivably sample all three. And, of course, you can always read some of the subject matter itself — a science fiction book or two. Lord knows there's enough of it.

Daniel Dern, who graduated from M.I.T. in 1973, is Technical Editor for Prime Computers. He attended the Clarion Science Fiction Writers Workshop in 1973 and has published science fiction in Galaxy, Analog, *and* New Dimensions. *He has also written on such diverse topics as folk music, feminism, and tiddlywinks.* □

Monster Mash

Search at Loch Ness: The Expedition of the New York Times *and the Academy of Applied Science*
Dennis L. Meredith
New York, N.Y.: Quadrangle/New York Times Book Co., 1977, 183 pp.; $9.95

Reviewed by Sara Jane Neustadtl

If there's anything better than knowing a celebrity, it's knowing somebody who's looking for one. The celebrity in this case is the monster of Loch Ness; the seeker is Dennis Meredith, author of *Search at Loch Ness* and, until quite recently, Managing Editor of this magazine.

Knowing this particular seeker is especially advantageous, in fact, because the celebrity has successfully eluded all attempts at capture. The trail of the wily beast, however is littered with argument-provoking evidence which Mr. Meredith documents enthusiastically and without prejudice. *Search at Loch Ness* tells not of the search for the monster, but of the search for scientific proof of the monster — and the distinction, as Mr. Meredith points out, is important.

Unfortunately for Nessie, the popular press shelves her with such phenomena as Atlantis and UFOs, a precarious alliance at best. Their only similarity is that many people don't believe in them, but would like to. The public is waiting for the scientific imprimatur.

But scientists, too, approach the subject cautiously. They have as many preconceptions about the beast as laymen, and demand "objective" evidence to prove or disprove them. So even in the scientific community the buck passes to a higher authority.

Seeing and Believing

The evidence that has caused the biggest stir has come from the efforts of Robert Rines, the lawyer-engineer who organized and led the most recent search through its six successive attempts. Dr. Rines gathered enough evidence to convince himself, M.I.T. Professor Harold Edgerton, expert photo analyst Charlie Wyckoff, and others that the loch contained large moving objects — most likely the fabled beast. All that remained was to satisfy those who demanded the sort of incontrovertible evidence that would overcome their skepticism. "If he [Dr. Rines] gave science the kind of evidence it understood — photographs, sonar traces, and bones — maybe then science would realize its neglect of the human evidence of sightings," writes Mr. Meredith. "It might begin to heed other kinds of human evidence, not accepted before because it couldn't be revealed in terms of decimal points and orders of magnitude," he continues. Science, after all, is "as dependent as magic on human perception and subjectivity, and it [is] as passive as magic, relying for its discoveries strictly on the phenomena nature allows it to witness."

One of Dr. Rines' strategies to convince the establishment was the publication of his findings in this magazine — admittedly not without a certain amount of trepidation on the part of the editors, who are perhaps even more sensitive than scientists to attacks on their credibility. Mr. Meredith made contact with Dr. Rines in January of 1976, proposing that *Technology Review* publish the pictures taken by the 1975 Loch Ness expedition, some of which had appeared in the British magazine, *Nature*. There Mr. Meredith's personal account begins.

Marshmallows in Hot Chocolate

Dennis Meredith regards science as empirical. He is fascinated by the ways in which scientific knowledge manifests the efforts of people, their machines, and their curiosity. As a result, his book is neither a dry, technical account nor a diary of a failed expedition (the evidence Dr. Rines sought was never obtained). Instead, the book manages to engage the lay reader without sacrificing accuracy. And it demonstrates Mr. Meredith's excitement in the search, his initial doubts about the beast's existence, and his own sensitivity to the pressures of the media groupies who gathered at the loch last summer and waited for Dr. Rines to produce his monster.

About three weeks into the expedition, Mr. Meredith writes, "It was high time for the beast to appear . . . Of course, it was silly to expect a thousand-year-old mystery to be solved in a single month, on-cue for radio, television, and newspapers. But such was the expectation, nurtured no doubt by the modern Western tradition of neatly packaged adventure stories, nicely fitting a newspaper column or a TV time slot, complete with commercials."

The commentators and their audiences waited in vain, but not without effect. The book's most important point is that both thousand-year-old mysteries and the scientists who investigate them are influenced and changed by public curiosity — directed in this case by the *New York Times,* who funded the expedition. But evidence for the beast's existence, to use one of Mr. Meredith's phrases, keeps popping up like marshmallows in hot chocolate. Maybe someday Nessie herself will pop up as well to defy the expectations of skeptic and believer.

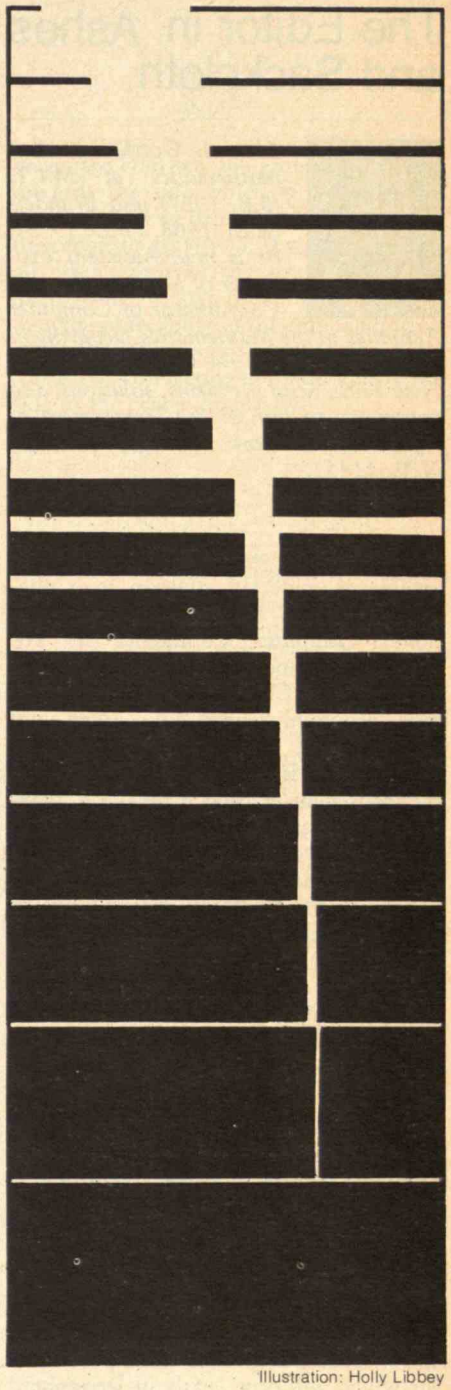


Illustration: Holly Libbey

Sara Jane Neustadtl is Managing Editor of Technology Review. □

The Editor in Ashes and Sackcloth

Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics and Coordinator of Computer Activities in the Mathematics Department at York College of the City University of New York. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y., 11451.

Hi. I hope that your summer was as enjoyable as mine. In addition to a one-week vacation, I attended the International Computer Conference in Toronto which included the World Computer Chess Championship. The winning program, Chess 4.6 (Aiken and Slate), played very fine chess. Its tournament play is at the expert level, and the consensus is that Chess 4.6 plays speed chess as well as a master (U.S.C.F ratings). If you have a chance to see a computer chess tournament, don't fail to take it; for one thing, you will not be asked to keep quiet!

As a new volume begins, let me answer some procedural questions about this column as well as explain the ground rules for new readers. Each issue I publish five "regular" problems (the first of which concerns either bridge or chess) and two of the "speed" variety. All problems are submitted by you, the readers. For the regular problems, I will publish someone's solution, chosen from among readers' responses, three issues later along with the names of everyone else who responded. (That means that solutions to the problems given below will appear in the February, 1978, issue of the *Review*, my deadline for which will occur early in December.) For the "speed" problems, which are supposed to be cute and easy, the procedure is different: if the author supplies a solution it appears at the end of the column containing the problem.

As you can see, this column is only as good as its readers. Currently I have a two-year backlog of ordinary problems and about a one-year backlog for chess, "speed," and bridge problems.

Finally, Bob Ferrara — an M.I.T. classmate — writes, "You may be the first member of the Class of 1967 to have his own puzzle column, but you are no longer the only one." He has had variants of acrostic puzzles published in the *Boston Herald American*.

Problems

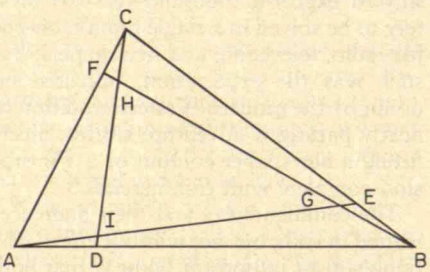
O/N 1 We begin this month with a bridge problem from Winslow H. Hartford: given the following hands, show how South can make six spades.

	♠ Q J 10 9 8 ♥ A 5 ♦ A 10 ♣ A K 9 3	
♠ A K 4 3 2 ♥ K 4 3 ♦ 8 3 ♣ 6 5 2		♠ 7 6 5 ♥ — ♦ J 9 7 6 5 4 2 ♣ Q J 10
	♠ — ♥ Q J 10 9 8 7 6 2 ♦ K Q ♣ 8 7 4	

O/N 2 Eric Jamin wants you to find three perfect squares such that the sum of any two is also a perfect square.

O/N 3 Naomi Markovitz is interested in trapezoidal representations; she writes: Let n be a positive integer. A trapezoidal representation of n is a decomposition of n into a sum of consecutive positive integers — e.g., 15 = 15, 15 = 7 + 8, 15 =4 + 5 + 6, 15 = 1 + 2 + 3 + 4 + 5. How many distinct trapezoidal representations does n have? Hint (courtesy of the editor): the answer is in terms of another, far more familiar, decomposition of n.

O/N 4 A geometry problem from Harold Heins: Given triangle ABC such that AB/AD = BC/BE = CA/CF = n. Draw AE, BF, and CD intersecting at points G, H, and I. What is the area of triangle GHI?



O/N 5 I consider problems like the following, from William J. Butler, Jr., to be combinatorial and not bridge problems: if a bridge foursome plays one hand every five minutes, how long will they have to play to have a 1 per-cent chance of a hand repeating? We require that each person has the same hand that he or she did on any previous deal. The two deals in question need not be consecutive.

Speed Department

O/N SD1. The editor knows a common English nine-letter word that contains only one vowel. Can you find one?

O/N SD2. Emmet J. Duffy submits the following: A post in a rectangular field is 17 feet from one corner and 33 feet from the diagonally opposite corner. If the post is 37 feet from the third corner, what is the distance from the post to the fourth corner?

Solutions

JAN 1 (as modified in May) With a no-trump contract and the following hands, how can South, who is on lead, make four of the remaining five tricks against any defense?

	♠ 8 ♥ Q 7 ♦ 9 ♣ 10	
♠ A ♥ 10 9 6 ♦ 8 ♣ —		♠ — ♥ — ♦ A 7 ♣ Q 9 6
	♠ — ♥ J ♦ J 5 ♣ A 8	

The following solution is from Scott Byron with help from Steve Weisman: The opening lead can quickly be narrowed down to a couple of choices. The right choice is the ♦5. If East uses his ♦A now, you will set up a squeeze in West. No matter what East returns, you win your remaining diamond and the ♣A in South. This forces West to make two discards in addition to the ♦8. Having discarded the ♣10 and the ♦9 already, your third discard from North will be the ♥7 if West discarded a heart and a spade, or it will be the ♠8 if he discarded the two hearts. You then lead the ♥J to the ♥Q and take your remaining winner.

If East ducks the diamond lead, you then put the squeeze on him. Lead back the ♠8 to West's ♠A, and he must return a heart. You had discarded the ♥J on the ♠8. You win the heart return with the ♥Q in North. If East discards two clubs, discard your ♦J. If he discards a club and a diamond, discard your ♣8. Play the ♣10 to your ♣A and take the remaining winner.

Also solved by Edwin S. Strauss, Edwin

H. Koehler, Mark Chen, Joe Feil, Bas Leeuwenburg, Bo Jansen, Alan Lemmon, Roger Yaseen, George Holderness, Sr., James W. Poynter, Michael A. Kay, Steven J. Projan, Willaim C. Everett, Ronnie Rylstein, Willaim J. Butler, Jr., Jerry Grossman, Warren Himmelberger, D. Pratt, David E. Romm, Howard Stevens, Thomas Mauthner, Bob Hess, D. Pomerantz, Mrs. D. S. Floyd, Paul M. Knopf, Elmer C. Ingraham, Ron Adelsman, Bowman Cutter, Anthony J. Albanese, Richard I. Hess, Albert J. Fisher, N. Neuberger, R. Robinson Rowe, Jacob Bergmann, Jeffrey M. Bowen, an anonymous employee of General Mills Chemicals Inc., and the proposer, Emmet J. Duffy.

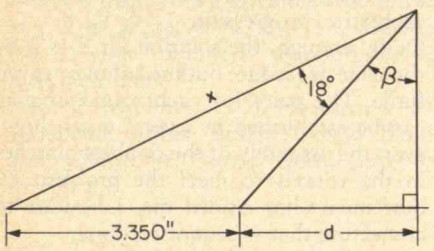
MAY 1 White begins a chess game with the usual set-up, while Black has only his king (in the usual position). What is the minimum number of moves White needs to achieve mate, assuming Black tries to avoid it? Is the first man moved by White the same in all minimal solutions?

The responses from William J. Butler, Jr., and Jeffrey M. Bowen are quite similar. Both use the queen and one rook to mate in eight moves and in both solutions, Black's moves are immaterial. One solution is:

1	P-K4	
2	Q-R5	Black's king now confined to three ranks
3	P-KR4	
4	R-R3	
5	R-KN3	
6	R-N6	Black's king now confined to two ranks
7	Q-R7	Black's king now confined to one rank
8	R-N8	Mate

Since the first and third moves may be permuted, the first move is not unique.

MAY 2 A typical drill-pattern problem; solve for x:



This problem was well received, and nearly everyone's solution is correct. The following is from Robert A. Stairs:

$$d/5 = \tan \beta \qquad (1)$$

$$(d + 3.350) / 5 = \tan(\beta + 18°) = (\tan \beta + \tan 18°) / (1 - \tan \beta \tan 18°) \qquad (2)$$

In (2) substitute d/5 for tan β from (1). The result is a quadratic in d which may be solved. Then, by Pythagoras,

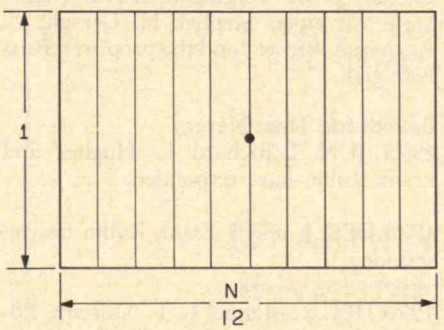
$x^2 = 5^2 + (3.350 + d)^2$,
and x = 8.678 inches.

Also solved by William J. Butler, Jr., Michael A. Kay, Erwin S. Strauss, Lindsay Faunt, Morrie Gasser, Gerald Blum, David C. Allen, Arthur L. Mavis, Serge Loussarian, John E. Prussing, Mr. and Mrs. D. Szper, Richard Berkof, Eugene McManus, Roy Sinclair, S. K. Bhalla, Winslow H. Hartford, Ed Parks, Norman M. Wickstrand, Joe Lacey, W. M. Leeds, Thomas Parrish, David Emmes, Frank Rubin, Norman Spencer, W. M. Cheung, Arthur L. Kaplan, Emmet J. Duffy, Frank Carbin, William Schoenfeld, Harry Zaremba, Avi and Bernice Ornstein, Rich Clark, Warren Lane, P. Michael Jung, John E. Morse, Carl M. King, and Henry Fleischer.

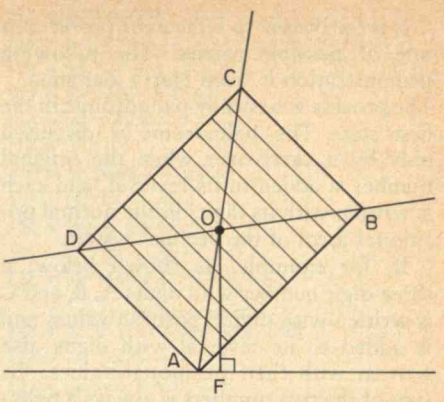
MAY 3 Given a "super-coin" made of N coins epoxied together in a cylindrical form. Assuming that the diameter of a coin is 12 times its thickness, what is the nearest integer N for (a) the "super-coin" with equal chances of heads, tails, or edge? (b) the "super-coin" with equal chances of face or edge?

I may be a stickler but I am not completely satisfied with any of the solutions submitted. My complaint is that no one's analysis includes the rotation of the coin. Several people just ignored the issue and many explicitly assumed that the rotation is not to be considered (certainly better than ignoring it). A few gave some sort of argument, but I found none of these convincing. In particular, saying that the various contributions will cancel out begs the question. The proposer claims that for a "super-coin" the angular velocity will be small for a normal flipping action. True enough, but the angular momentum will not be small. Once you decide to ignore rotations, the analyses look much better. The following is from Ed Parks:

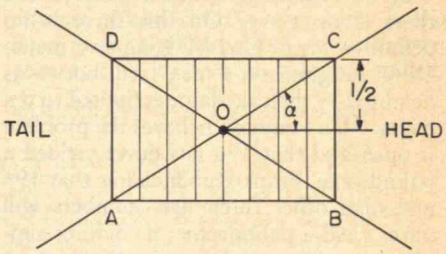
The chances of getting a head, tail, or edge depend on how the center of gravity of the "super-coin" is oriented over the sides when the coin hits the ground. The problem can be completely posed in two dimensions due to the rotational symmetry of the third dimension:



Here we are looking at the coin with the edges of the N pennies facing us. Let the diameter of a coin be one unit; then the dimensions of the "super-coin" are 1 x N/12.



When the coin hits the ground, it will tip towards the side which is crossed by a perpendicular to the ground, OF, through the center of gravity O. If we assume that all orientations of the coin are equally likely when it first touches the ground, then the probability of the coin landing on a given side is proportional to the angle formed by connecting the endpoints of the side to the center of gravity.



Thus:
Pr(H) = (Angle BOC) / 360°

Pr(T) = Pr(H) = (Angle AOD) / 360°

Pr(E) = 2(Angle DOC) / 360° = 1 − 2·Pr(H)

Let α = (Angle BOC) / 2. Then tan α = ½/ (N/24) = 12N.

The first problem is to find N such that Pr(H) = Pr(T) = Pr(E) = ⅓:

Pr(H) = (Angle BOC) / 360° = α / 180° = ⅓ ⇒ α = 60°

tan 60° = 12/N ⇒ N = 12/ (tan 60°) = 6.93.

The nearest integer N is thus seven pennies.
The second problem is to find N such that [Pr(H) + Pr(T)] = Pr(E) = ½:

Pr(H) = (Angle BOC) / 360° = α / 180° = ¼ ⇒ α = 45°

tan 45° = 12/N ⇒ N = 12/ (tan 45°) = 12 pennies.

Also solved by P. Michael Jung, Harry Zaremba, Frank Rubin, Winslow H. Hartford, Roy Sinclair, Eugene McManus, Mr. and Mrs. D. Szper, John E. Prussing, Erwin S. Strauss, William J. Butler, Jr., and R. Robinson Rowe.

MAY 4 Is there a proof for the proposition that if you reverse a number and add it to itself, and repeat that process, you will eventually get a palindrome?

It is fairly easy to reduce the problem to one of possible carries. The following demonstration is from Harry Zaremba: The process is basically palindromic in the first step. The palindrome is disguised only by a carry-over when the original number is added to its reversal, and each is written with its digits in the normal positional form of the decimal system.

If, for example, as shown below, a three-digit number with digits A, B, and C is written with digital position values and is added to its reversal with digits also written with their positional values, the sum of the two numbers is always a palindrome when carry-over is ignored:

100 A	10 B	C
100 C	10 B	A
100 (A + C)	10 (2B)	(A + C)

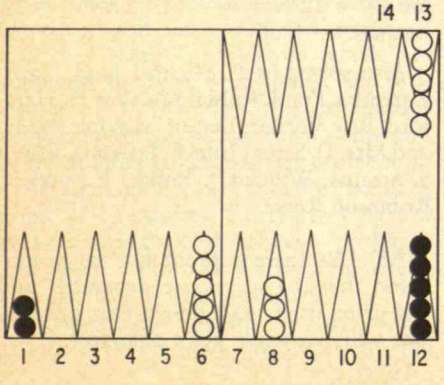
The palindrome will not be apparent until a point is reached in the process when no carry-over is existent.

But now, going beyond Harry Zaremba's analysis, comes the interesting part: Will we necessarily reach a point where there is no carry? On this there is no definitive word. Carl M. King sent me an HP67 program on a mag card, but — as he noted — the calculator is limited to ten digits. Alan Lemmon believes the problem is open and that 196 has never yielded a palindrome. Frank Rubin claims that 196 and nine other three-digit numbers will never yield a palindrome; he did not supply a proof (but claims one is known).

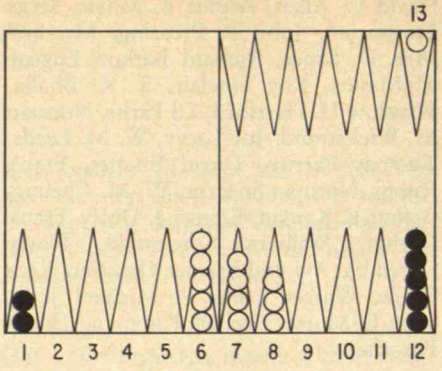
Also solved by Winslow H. Hartford, Erwin S. Strauss, and John E. Prussing.

MAY 5 Given the original backgammon board set-up, play any three initial dice of your choosing such as 6-6, 5-5, 6-1, etc., to lock up the two black pieces in the corner of your home table with a perfect prime. That is, the black pieces in the corner are locked in such that they cannot move even one space (or point) with the six openings in front blocked by closed points. (Assume the black corner pieces stay in one place.)

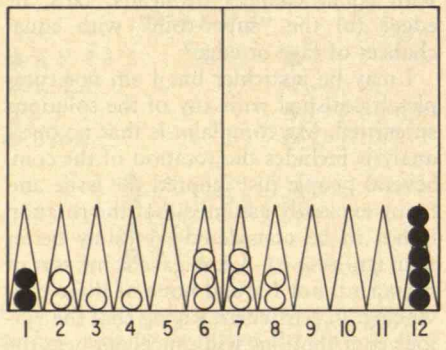
As I mentioned in May, I am not a backgammon expert by any means. I was therefore pleased to note that the solutions to this problem are not controversial. The following is from Bill Blake: This is the position at the start of the game:



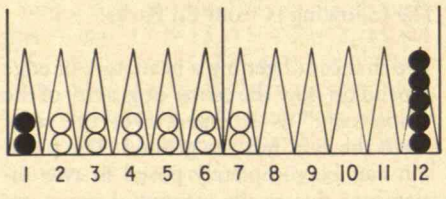
First roll 6-6. Move four men from space 13 to space 7. The result looks like this:



Second roll 4-4. Move two men from space 6 to space 2, one from space 7 to space 3, and one from space 8 to space 4. The result looks like this:



Last roll 3-3. Move two men from space 8 to space 5, one from space 6 to space 3, and one from space 7 to space 4. The result looks like this:



Also solved by Jeffrey M. Bowen, W. Everett, Jacob Bergmann, David Heller, Steve Altchuler, Stephen H. Gersuk, G. Raymond, Brown, and the proposer, Russ Nahigian.

Better Late Than Never

1975 JUN 1 Richard L. Hughes and Frank Rubin have responded.

1975 DEC 1 and 5 Frank Rubin has responded.

1976 DEC 2 Manuel R. F. Moreira, Edward Lunch, Benjamin Rouben, and Gerald Blum have responded.

DEC 3 Benjamin Rouben and Gerald Blum have responded.

1976 DEC 5 Harry Zaremba has submitted the following solution for n = 4: There are 15 different rounds of doubles matches with four matches in each round. Every player is paired only once with each other participant and opposes each player twice. The players are identified by numbers 1 to 9 and letters A to G:

Round	*Doubles matches*			
1	12:34	56:78	9A:BC	DE:FG
2	13:57	24:68	9B:DF	AC:EG
3	14:58	23:67	9C:DG	AB:EF
4	15:AE	26:9D	37:CG	48:BF
5	16:BG	25:CF	38:9E	47:AD
6	17:CE	28:BD	35:AG	46:9F
7	18:AF	27:9G	36:CD	45:BE
8	19:4C	2A:3B	5D:8G	6E:7F
9	1A:6D	29:5E	3C:8F	4B:7G
10	1B:7D	2C:8E	39:5F	4A:6G
11	1C:2B	3A:49	5G:6F	7E:8D
12	1D:3F	2E:4G	59:7B	6A:8C
13	1E:69	2D:5A	3G:8B	4F:7C
14	1F:2G	3D:4E	5B:6C	79:8A
15	1G:89	2F:7A	3E:6B	4D:5C

The attack for the solution was begun by arranging the pairs in the form of an upper triangular matrix of which the first-row elements consisted of player 1 matched consecutively with players 2 to G, the second row had player 2 matched with players 3 to G, the third row had player 3 matched with players 4 to G, etc. The pairs for each round were selected in a pattern symmetrical about the partial main diagonal upward to the right, with the last round having elements of the diagonal. The pair elements of each round then were arranged in columns in which the pairs were placed from top to bottom in a progressively increasing order of magnitude represented by the number or letter assigned to the player on the left of the pair symbol. The topmost elements of each column corresponded to the first row of the original matrix. From this point, the pairs in each column were formed into doubles matches. The matches in the first eight rounds were chosen in an orderly pattern without any difficulty; however, in subsequent rounds, the orderliness vanished, and the solution was completed by sheer illogical logic, mental muscle, and a bit of luck. It is my conjecture that solutions are possible for all n which are in the geometric progression 1, 2, 4, 8, ... Oddly enough, the solution for n = 3 by the same procedure outlined above proved futile. The pairs for each round of play can be established in several ways; however, the assembly of the doubles matches in the rounds to meet the problem requirements has eluded me. I hesitate to conjecture that it cannot be done.

Y 1976 Harry W. Hazard.

1977 JAN 2 Harry Garber, Jacob Bergmann, and George H. Ropes have responded.

JAN 3 Frank Rubin and Richard I. Hess.

JAN 4 Joseph E. Keilin points out that there is another solution with the swimmer heading obliquely upstream. I am not sure that this answers the question, "At what angle should he point himself?" Morton Hecht, Serge Loussarian, and Richard L. Schapker, Gerald Blum,

Mario Diquilio, Henry Heiberg, and Richard Hess have found alternate methods of solution.

JAN 5 C. M. Delaney gets the same ratio as published but believes that t and d should be 1.5844×10^{-5} cm. and 4.826×10^{-4} cm., respectively. Gerald Blum and Richard Hess have also responded.

FEB 1 Ted Mita, Frank Rubin, and Gerald Blum have responded.

FEB 3 Bob Lutton and I hang our heads in shame. The following blast is from Leo G. Chouinard II:
Let me add a few more ashes to the sackcloth I hope you are already wearing as a result of the "solution" you published. In Nebraska, at least, the system

$3x_1 = a^2 + b^2 + c^2 - 2d^2$

$3x_2 = a^2 + b^2 - 2c^2 + d^2$

$3x_3 = a^2 - 2b^2 + c^2 + d^2$

$3x_4 = -2a^2 + b^2 + c^2 + d^2$

has a solution with x_1, x_2, x_3, and x_4 integers if each of the right sides is congruent to 0 (mod 3). But since $-2 \equiv 1$ (mod 3), each of the right sides reduces to

$a^2 + b^2 + c^2 + d^2$ (mod 3).

Since $y^2 \equiv 1$ (mod 3) if 3 does not divide y, and $y \equiv 0$ (mod 3) if 3 divides y, the solutions to

$a^2 + b^2 + c^2 + d^2$ (mod 3) $\equiv$ (mod 3)

are all integer values of a, b, c, and d such that either all four are divisible by 3 or exactly one of the four is divisible by 3. As your solution (implicitly) noted, if we assume all integers used are positive, then the condition that the x's be distinct is just the assumption that a, b, c, and d are distinct, and if by symmetry we also assume $a < b < c < d$., i.e., $x_1 < x_2 < x_3 < x_4$, our requirement that the x_1's are positive is just $2d < a^2 + b^2 + c^2$. In particular, a = 8, b = 9, c= 10, d = 11 gives the solution $x_1 = 1$, $x_2 = 22$, $x_3 = 41$, $x_4 = 58$, which is 1/9 of your "smallest" solution. Better luck next time.

R. V. Mullikin, L. F. Howard, L. D. Woodruff, Frank Rubin, Gerald Blum, and Charles F. Rozier have also responded.

FEB 4 Ted Mita, Frank Rubin, and Gerald Blum have responded.

M/A 1 Jeffrey M. Bowen, Ted Mita, and Mr. and Mrs. D. Szper have responded.

M/A 2 James T. Aslanis, Jr., and John E. Prussing have responded.

M/A 3 Jonathan G. Bressel, Raymond Gaillard, James T. Aslanis, Jr., Mr. and Mrs. D. Szper, and Ted Mita have responded.

M/A 4 Ted Mita and Mr. and Mrs. D. Szper have responded.

M/A 5 Ted Mita, Mr. and Mrs. D. Szper, Jonathan G. Bressel, and Raymond Gaillard have responded.

NS 6 John and Karen Terrey, Charlie Bahne, Harry Zaremba, and Ted Mita have responded.

JUN SD1 Joseph Feil points out that the width should be 34 feet 8 inches.

PERM-2 Andy Egendorf notes that 99 = 4! /. (4!) − 4/4. (This use of . is all right; .4 = .4444 . . . is not.) So up to 100 we are missing only 73, 77, 87, and 93. The rules are given in March/April. Pooling the responses received from H. W. Hazard, Harry Zaremba, Robert Roth, George H. Ropes, Greg Schaffers, and Edward Lynch, I present the following extension up to 130. We use ** for exponentiation. Beyond 130 the density of solutions drops markedly.

101 = √4/.4+ (4!)*4
102 = (4!)*4 + 4 + √4
103 =
104 = (4!)*4 + 4 + 4
105 = (44 − √4)/.4
106 = (4! + √4)*4 + √4
107 =
108 = (4! + √4)*4 + 4
109 = (44 − .4)/.4
110 = (4! − √4)*(√4/.4)
111 = 444/4
112 = 4!*4 + 4*4
113=
114 = 44/.4 + 4
115 = (4!*√4 − √4)/.4
116 = (4!*√4)/.4 − 4
117 =
118 = (4!*√4)/.4 − √4
119 = (4!*√4 − .4)/.4
120 = (4!/.4)*4/√4
121 = (4!*√4 + .4)/.4
122 = (4!*√4)/.4 + √4
123 = $\sqrt{\sqrt{\sqrt{(\sqrt{4}/.4)^{**}(4!)}}} - \sqrt{4}$
124 = (4!*√4)/.4 + 4
125 = (4!*√4 + √4)/.4
126 = (4!/.4)/.4 − 4!
127 = (4**4 − √4)/√4
128 = 4*4*4*√4
129 = (4**4 + √4)/√4
130 = (4!*√4 + 4)/.4

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O/N SD2 Since the sum of the squares of the distances to two diagonally opposite corners is the same as the sum of the squares of the distances to the other two corners, then if x is the unknown distance,

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Drawing With Your Eyes

Look at the top of a television tube; a spot appears. Move your eye down the tube; the spot becomes a line.

An artist's fantasy — to be able to draw with the eyes — has been fulfilled.

Eye-movement monitors are not new, and this one, the product of research at M.I.T. and the Charles S. Draper Laboratory, is not elaborate. But it is unique: long-persistence phosphor in the television tube means that whatever is "written" on it by the eye will remain visible for several minutes.

Derith Glover, an artist affiliated with the Center for Advanced Visual Studies, finds the artistic possibilities intriguing; and Richard Warren, Director of the Center for Advanced Rehabilitation Engineering at the Draper Laboratory, is interested in prosthetic and therapeutic applications. For example, he thinks people who are unable to move and speak because of spinal injuries or nervous disorders may be able to use their eyes to write on the monitor. Though "there's a lot of work still to be done," Mr. Warren is optimistic because the system is inexpensive (less than $1,000) and technically simple. □

Legalizing Illegal Aliens

Irresistible economic pressures on both sides of the border power the illegal immigration of Mexican workers to the U.S. Not even "the most draconian" police action could halt the flow, and Professor Wayne A. Cornelius thinks legalized, temporary migration is a better solution.

Dr. Cornelius, Associate Professor of Political Science at M.I.T., is director of a four-year study of illegal migration to the U.S. sponsored by the Center for Population Research of the National Institutes of Health. He suggests that the U.S. issue temporary worker visas permitting up to six months' employment each year, the Mexican recipients required to return to their homeland at the visas' expiration.

Professor Cornelius says this proposal would simply make legitimate what hundreds of thousands of Mexicans do each year anyway — enter the U.S. for four to six months and then return home with their earnings, which are more than workers would receive for a year's similar work in Mexico. The traffic of workers across the border is important to both sides — a source of labor for U.S. small business and agriculture, and a "political and economic safety valve" for the Mexican economy in which many workers are underemployed. The Mexicans represent no competition for American workers, says Professor Cornelius; they take dirty, physically demanding jobs in which few Americans have any interest. □

Carter's Energy Plans — Good for New England

President Jimmy Carter's energy plans seem to be good for the country — and even better for New England, says Professor John Donovan after analyzing them in the computer-based New England Energy Management Information System (N.E.E.M.I.S.) at M.I.T.

The basic point, he says, is the President's proposals to raise energy costs across the nation — and hence reduce New England's competitive disadvantage.

But in some respects New Englanders have little to gain. Benefits for the installation of storm windows and doors will be denied to most homeowners here because they've already done the job: 84 per cent of New England homes now have storm windows, 77 per cent have storm doors, and only 18 per cent of all New England houses have no insulation at all.

Another problem for New England, too: the region is now heavily dependent on imported oil. Conversion to coal would be hard; New England railroads aren't up to the job of bringing it here. □

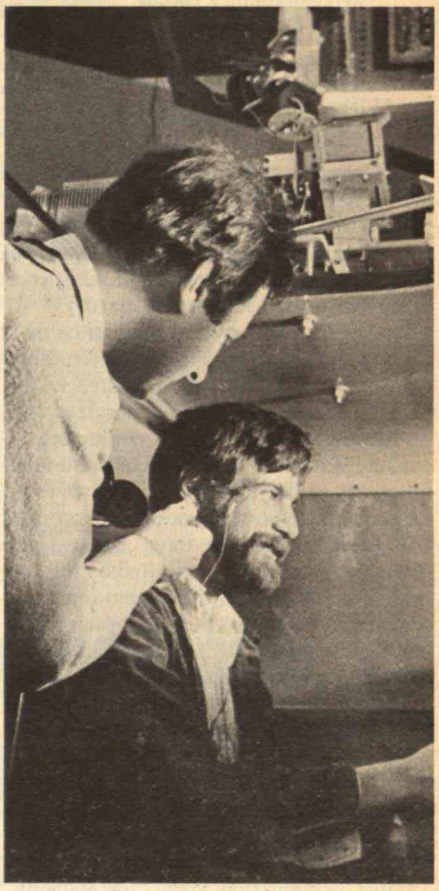
Solar Irrigation

An array of 120,000 photovoltaic cells 650 feet long by eight feet high has been irrigating 80 acres of corn and soybeans on an experimental farm near Mead, Neb.

The cells convert the sun's rays into up to 25,000 watts (peak) of electric power; this maintains batteries from which power is drawn through inverters to pump 1,000 gallons per minute of water from a reservoir onto the thirsty fields.

At the end of the growing season, the same power source will be tested to drive large fans for drying the 12,000 bushels of corn expected to come from the field.

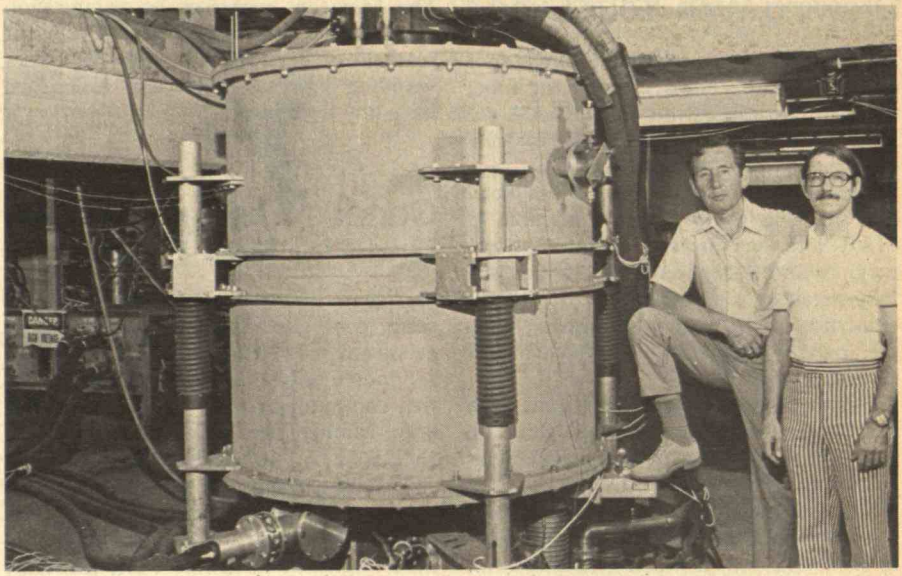
It's a joint project of the Photovoltaic Project at M.I.T. Lincoln Laboratory, the University of Nebraska, and the Division of Solar Energy of E.R.D.A. Ronald W. Matlin, Assistant Manager of the Lincoln Project, admits that solar cells are "much too expensive" for use except in experimental systems; but it will be a different story if and when E.R.D.A.'s 1986 goal of solar cells at 50 cents per watt (compared to today's $15.50) is achieved. □



Professor Laurence R. Young (left) is one of the nation's experts on human orientation systems; now he and his M.I.T. colleagues (including graduate student Greg Zacharias, right) are designing experiments on orientation in the gravity-less environment of a spacecraft to be performed by astronauts aboard the first Space Shuttle flight in 1980.

Orientation in Zero Gravity

Space motion sickness represents a failure — usually temporary — of a human's orientation system to adapt to zero gravity, which means that one of the information channels on which it typically relies is inoperative. Experiments to improve our understanding of space motion sickness have now been designed by Professors Laurence R. Young and Charles M. Oman of the M.I.T. Department of Aeronautics and Astronautics, and they will be included in the programs of the astronauts on the first Space Shuttle flight in 1980. Tests will seek to detect changes in the function of the inner ear at zero gravity and to study eye-ear interactions. □



The world's strongest magnetic field was created inside this cylinder — a record 301,000 gauss in a tiny experimental cavity in the center of the cylinder. Shown with the National Science Foundation Magnet are its designers, Mathias J. Leupold (left) and Robert J. Weggel of the Bitter National Magnet Laboratory. (Photo: Calvin Campbell)

World's Strongest Magnet: 301,000 Gauss at Bitter Laboratory

The strongest continuous magnetic field ever generated by man — 301,000 gauss, almost 600,000 times larger than the earth's natural magnetic field — was produced last summer in the M.I.T. Francis Bitter National Magnet Laboratory.

It was done in a hybrid magnet consisting of a three-foot-diameter superconducting outer coil and a pair of nested water-cooled inner coils. Once energized, the outer coil — being superconducting — consumes no power while contributing 82 kilogauss to the total field. This saves 12 megawatts of power, enough to produce 216 kilogauss in the inner coils. Three more kilogauss are contributed by the iron cylinders which hold the system together.

The 301-kilogauss field occurs in an experimental cavity 3.2 centimeters in diameter at the center of the inner coils.

This record-powerful magnet is named for the National Science Foundation, which sponsors most of the Bitter National Magnet Laboratory's scientific work; its principal designers are Mathias J. Leupold and Robert J. Weggel of the N.M.L. staff.

They explain that such "ultra-strong" magnetic fields are "eagerly sought" for scientific and engineering experiments throughout the world, and N.M.L. will soon have a permanent installation where fields of this size are available to workers bringing apparatus to Cambridge for test. In particular, Mr. Leupold mentions worldwide interest in magnetohydrodynamic and fusion power generators, both concepts depending for success upon high-intensity magnetic fields. □

New Research

Among research grants and new projects announced at M.I.T. during the summer:

Can Soot Cause Cancer?
William G. Thilly, Associate Professor of Toxicology who specializes in human cell studies in the Department of Nutrition and Food Science, is the leader of a multi-disciplinary research team testing the mutagenic properties of soot from the combustion of fossil fuels.

Some organic materials in soot are believed to have properties which can cause cancer — as well as genetic and other cellular changes — in humans. The goal of the new project, sponsored by the Energy Research and Development Administration through its Office of Environment and Safety, is to test the effects of these organics on human cells in culture.

Energy Needs Today and Tomorrow
How much energy does an institution the size of M.I.T. really need? From what sources can it come?

For the answers to these questions, wait for the Institute's "total energy study" which seeks an assessment of present and long-range future energy needs. A $50,000 preliminary program is now under way to identify promising opportunities for detailed future studies.

The Cause and Cure of Leukemia
Two fellowship grants, a total of $56,000, have come to M.I.T. from the Leukemia Society of America, Inc., to support research on technical issues in understanding leukemia; they'll be used by post-doctoral fellows in the Center for Cancer Research.

Wave Power?
Can waves in the ocean be turned into useful power? Professors Chiang C. Mei (Civil Engineering) and A. Douglas Carmichael (Ocean Engineering) will seek an answer in research funded by the M.I.T. Sea Grant Program, the National Oceanic and Atmospheric Administration and the U.S. Office of Naval Research. Plenty of energy is available — 36 megawatts per mile of crest in five-foot waves which come at ten-second intervals, 560 megawatts in a mile of 20-foot waves arriving at the same interval. Stephen W. Salter, a British engineer, has shown that — at least theoretically — 80 to 90 per cent of this energy could be extracted by a floating mat or buoy. The problem is whether Mr. Salter's theory can be translated into fact.

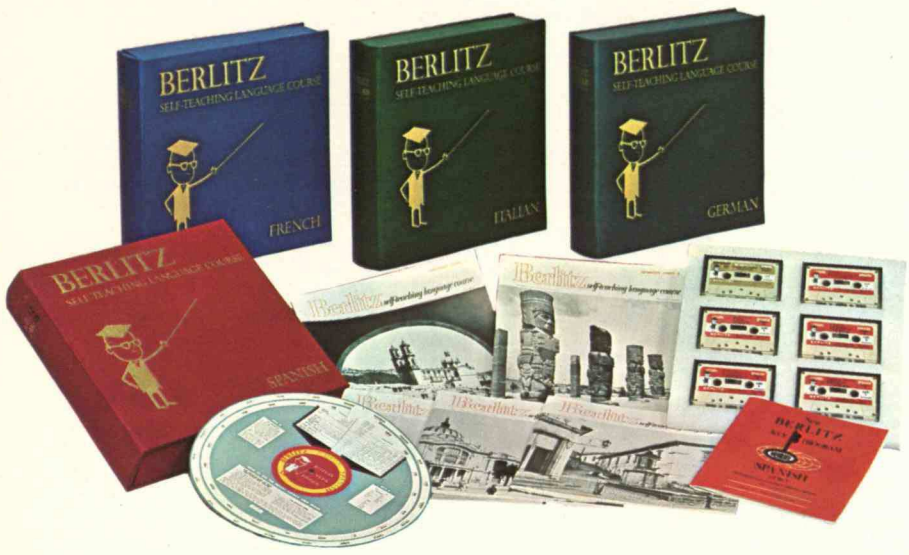
Managing the Uncertainty of Energy

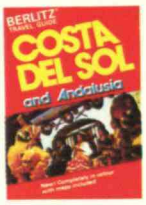
How should a thoughtful, effective executive respond to the "energy crisis" in planning for his company's future?

An all-day symposium to help answer that question will be held by the M.I.T. Alumni Center of New York (in association with the M.I.T. Industrial Liaison Program) at the New York Hilton on Thursday, December 8. Speakers will include Ben C. Ball, Vice President — Planning, Gulf Oil Corp; John J. Donovan, Associate Professor of Management Science, M.I.T.; Ezra D. Ehrenkrantz, New York architect; George N. Hatsopoulos, President of Thermo Electron Corp.; J. Herbert Hollomon, Director of the Center for Policy Alternatives, M.I.T.; James M. Utterback, Research Staff, Center for Policy Alternatives; and Jerome B. Wiesner, President of M.I.T.

"Industry has always operated under uncertainty in an environment ranging from receptive to hostile," says Myron A. Exelbert, Chairman of the symposium. "The energy question represents an expanding set of uncertainties. Dealing with them will be the subject of this program."

Attendance is *not* limited to alumni of M.I.T.; further information and reservations are available from the Center at 50 East 41st Street, New York, N.Y., 10017, telephone (212) 532-8181.





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